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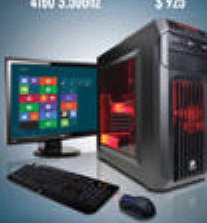

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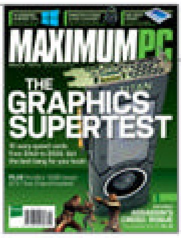

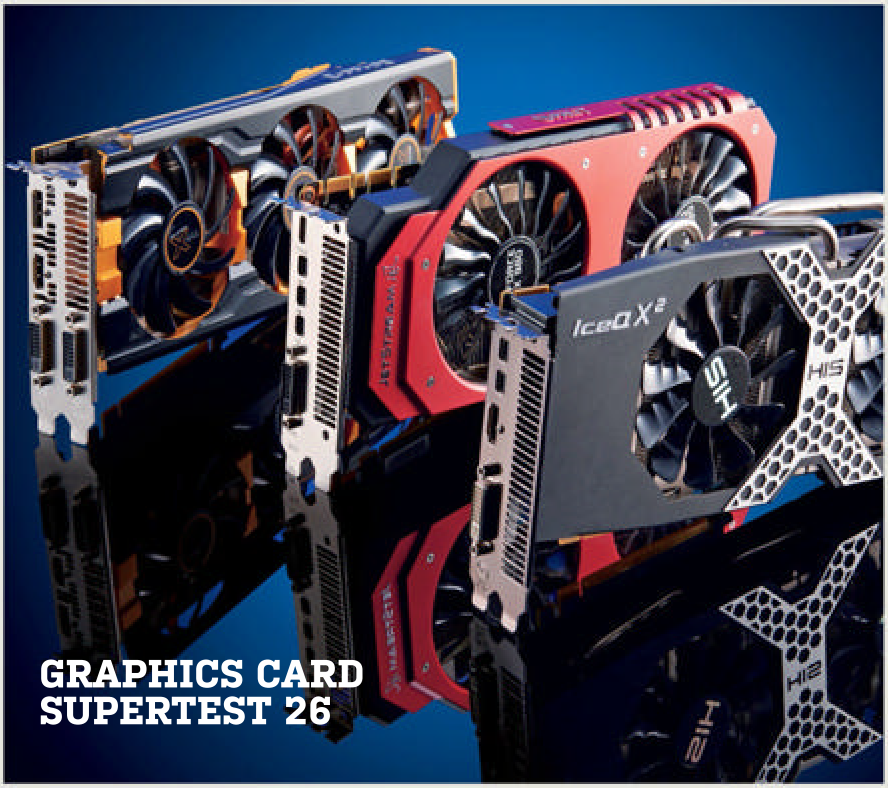

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Tuan Nguyen

BUILD. INSTALL. TWEAK. PLAY.

EVER SINCE I WAS ABLE to use a keyboard, I've been a fan of several things: playing the latest games, tweaking and optimizing, and trying something new. Now, some of these things don't always go well together, because as an early adopter, you'll often find yourself troubleshooting rather than using. But I just can't help it, I always have to dive deep and tinker away.

Usually, the only way to be able to play the latest games is by making sure your system is relatively up to date. Most PCs built in the last two years or so should be able to tackle whatever titles are available right now. Out of all the components you could think of though, the GPU is the most critical component to game performance, and in this issue we deliver the goods for you. Head to page 26 to follow us testing a barrage of GPUs. By the time you're through, you should have an excellent idea of your next upgrade. Granted, if you just want the best available GPU money can buy, Nvidia's new Titan X is a safe bet for "only" $999. Read our review of it on page 78.

Another area of my own computing experience that I love is optimization. There's no sense in tossing together a creamy recipe for PC goodness, if what you end up with is sludgy performance. I'd spend countless hours tweaking the living daylights out of Windows to make sure I had the leanest possible running environment. Nothing extra, everything optimized. I think at some point my parents must have thought I was developing some sort of obsessive behavior. The second major feature of this issue is all to do with tweaking and tuning Windows, which, by the way, should be at the top of every reader's list of things that should be done on a regular basis. Find that on page 42. Unless, of course, you don't use Windows.

Lots of readers have written in asking us to cover Linux. Let me get straight to the point: OK. This is exactly what we're going to do, starting with our Linux feature on page 52. At this point, I'd like to also let you know that we have a new associate editor, who specializes in Linux! You can expect us to cover topics such as different distros, installing and configuring, dual-booting, installing packages, setting up firewalls, and more. Don't worry, we'll touch base on everything.

Outside of this month's issue, I wanted to recommend something to those who grew up on games. These days, I don't have much spare time to sit down and plow through a long game, but when I do, I try to look for something captivating. I have to tell you, it's been a long time—probably since my Mario days—that I've played a game this good. If you have the chance, look for a game called *Ori and the Blind Forest*, which is available on Steam. You won't regret it.

Tuan Nguyen is Maximum PC*'s editor-in-chief, also known as "the pointy end of the stick." He's been writing, marketing, and raising hell in the tech industry for 19 years.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

The Future of GPU Compute

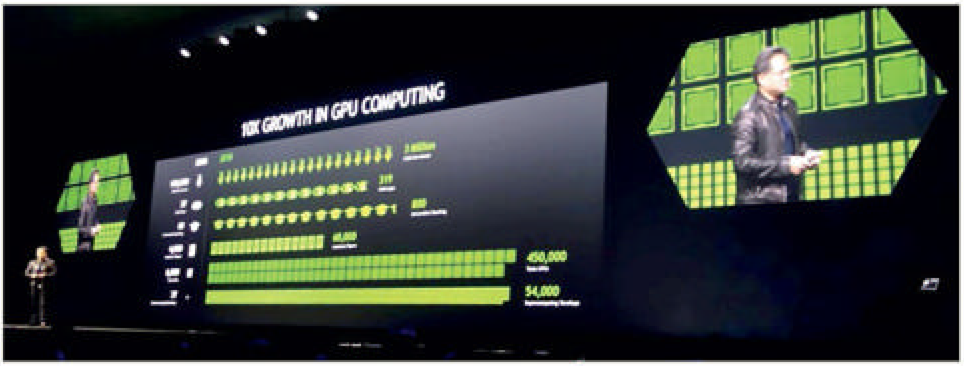
Could self-driving cars mean human drivers are outlawed?

AT NVIDIA'S GPU Technology Conference in March, CEO Jen-Hsun Huang formally launched the Titan X (read our full review on page 78). But as well as unveiling its $1,000 graphics card, Nvidia also announced it's entering the PC-selling arena. Dubbed the Digits Devbox, the rig has four Titan Xs and will cost a staggering $15,000.

Why so much, you ask? Because it's designed for developers, and not meant for the retail market. The Devbox is specifically aimed at devs interested in doing research in the deep-learning field, a focal point of Nvidia's presentation.

GTC really is an event aimed at GPU compute, and Jen-Hsun Huang took to the stage to claim the company has seen a 10x growth in the area, adding that there are dozens of high profile companies, such as Facebook, IBM, and Microsoft, already involved with GPU-accelerated deep-learning research. On that note, Huang claims the Titan X is exponentially faster than a 16-core Xeon CPU, giving as an example the AlexNet benchmark, which took the CPU 43 days to finish. The Titan X only needed 2.5 days.

Deep learning will greatly contribute to medical research, believes Huang, arguing it will help to predict things like the toxicity of new drugs, or understand gene mutation to prevent diseases.


10X GROWTH IN GPU COMPUTING
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54,000

According to Nvidia, the company has seen 10x growth in GPU computing.

Machine learning, of course, isn't anything new. It's been in use since the '90s to allow machines to detect human writing, which we still use in banking technology today. But Huang says we're only at the beginning of machine learning, and showed off some case studies in which machines bested humans at detecting objects within images.

To take it a step further, Nvidia's CEO showed off some examples in which a computer not only detected what object was in an image, but used its own syntax to create a sentence describing the picture. We were shown an image with a bird perched in a tree. The computer then described the image as "A bird perched on a branch of a tree." It's kind of scary how accurate these machines can get, and we think even Skynet would approve.

Of course, these machines are only as smart as we allow them to be. On stage, Huang showed an example of Project DAVE (short for DARPA Autonomous Vehicle), which is essentially a small toy car with a computer brain.

Given 225,000 images of someone's backyard to process, DAVE is able to traverse the terrain with relative ease. With less images to work with, however, DAVE doesn't have enough data on the terrain and we were shown a video where it spent a lot of time crashing into rocks and getting stuck along walls. Huang then transitioned into talking about Nvidia's Drive PX system, which he asserts is 3,000 times faster than DAVE. He revealed that development kits for Drive PX will be available in May 2015 and cost $10,000.

Nvidia undoubtedly hopes its Drive PX system will help advanced driving assistance systems (ADAS) usher in the era of self-driving cars. To illustrate that point, Nvidia brought Tesla CEO Elon Musk onto the stage.

Musk tried to quell doubts about self-driving cars, and said that getting them to a point where they are safer than human drivers is going to be easier than most people think. Not only that, but Musk added they will be "magnitudes safer" than human equivalents. He can even envision a future in which human drivers will be outlawed due to safety issues.

Self-driving cars aside, Nvidia revealed that Pascal, its next GPU architecture, would be coming out in 2016. While details remain scarce, Pascal will feature mixed precision, 3D memory, and NVLink, which will allow GPUs to communicate much faster than through the current PCIe standard. **–JT**

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The FCC's handed Verizon a public spanking.

FCC PRODUCES NET NEUTRALITY RULE BOOK

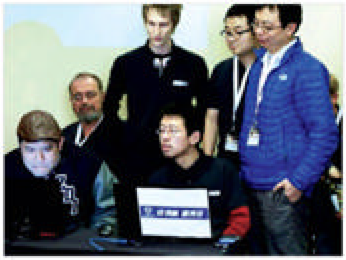
JUST A FEW WEEKS after the FCC reclassified the Internet from an information service to a utility, chairman Tom Wheeler released the full rules surrounding net neutrality, officially called the Open Internet Order. The rules themselves have not changed. Neither has the essence of what we've known up until this point. The following three hardline rules stand firm.

One, no blocking. Broadband providers may not block access to legal content, applications, services, or non-harmful devices. Two, no throttling. Broadband providers may not impair or degrade lawful Internet traffic on the basis of content, applications, services, or non-harmful devices. Three, no paid prioritization. Broadband providers may not favor some lawful Internet traffic over other lawful traffic in exchange for consideration of any kind—in other words, no "fast lanes." This rule also bans ISPs from prioritizing content and services of their affiliates.

There are over 700 other rules not being applied to this order that usually apply to utilities, such as prices regulated by the government. However, local municipalities are now open to providers coming in and setting up camp and delivering more competition. The FCC, calling out Verizon as an example, also stated ISPs cannot play it both ways, sometimes categorizing themselves as common carriers and sometimes not, depending on where the business advantage lies.

Prior to this ruling, questions floated on how specific the FCC would be. Many were concerned about price hikes and taxation, but these concerns can now be put to rest. In creating the Open Internet Order, the FCC also decided to publicly govern itself, inserting checks and balances to ensure it couldn't overstep its own rules. **–TN**

HACKERS PAID TO BREAK BROWSERS



EXPLOIT CHROME, IE, AND SAFARI—GET $225,000

WEB BROWSER VENDORS often tout security as a primary selling feature of their products. But at the annual Pwn2Own hacking contest, Internet Explorer, Firefox, Chrome, and Safari had to eat humble pie as they all fell prey to remote code execution exploits by the second day. Prizes were awarded, with the biggest purse going to Jung Hoon Lee, screenname lokihardt. Lee raked in $110,000 from faults found in Google Chrome alone. He also took home $65,000 for breaking IE and $50,000 for Safari. Participants took home a combined total of $442,500 for their work. Mozilla was the first to react, releasing security patches for Firefox three days after the exploits were made public. Outside of contests, Google offers prizes of $500 to $50,000 for those who can break Chrome. **–AC**

AMD ANNOUNCES FREESYNC MONITORS

Chipmaker bets on open-source to beat G-Sync

FreeSync-friendly: the BenQ XL2730Z

FANBOYS, GRAB YOUR FLAMETHROWERS: There's a new front in the AMD-Nvidia war. AMD announced four new monitors that will feature its new FreeSync tech, and was quick to pounce on Nvidia's competing standard, G-Sync. Simply put, both technologies allow displays to synchronize their refresh rate with that of the PC's video output. AMD came out swinging by claiming Nvidia's G-Sync reduces frame rates by 1.14 percent in a test using *Alien: Isolation*. It added that FreeSync will be open-source, use DisplayPort, and will be free from licensing fees. In comparison, Nvidia's G-Sync uses a proprietary module, proprietary code, and charges licensing fees. FreeSync refresh rates will have a range of 9–240Hz, while G-Sync has a narrower 30–144Hz. FreeSync monitor models include the LG 29UM67, the Acer XG270HU, the BenQ XL2730Z, and the LG 34Um67. **–SK**

Tech Tragedies and Triumphs

A monthly snapshot of what's up and down in tech

TRIUMPHS

SPARTAN DITCHES TRIDENT
Microsoft's doing its best to make Project Spartan less like IE, starting by dropping rendering engine Trident.

BROADBAND SPEEDS UP
US broadband customers saw an average increase of 10Mb/s in download speeds over the past year, but we're still ranked 27th worldwide.

PIRATES GET WINDOWS 10
Microsoft said users who pirated Windows 7 can upgrade to Windows 10, but the license for Windows 10 won't be considered legit.

TRAGEDIES

AMAZON'S MUDDY WATERS
Unlike Facebook, Google, and Twitter, Amazon isn't disclosing which governments request user data, or what types of data it hands over.

RADIOSHACK SELLS DATA
Electronics retailer RadioShack put its customer data up for auction after filing for bankruptcy.

END OF THE SILK ROAD
Two former federal agents face charges for stealing large amounts of bitcoin during the operation to shut down the dark web's Silk Road.

Tom Halfhill

FAST FORWARD

The Internet of Insecure Things

NOW THE INTERNET OF THINGS is spawning devices that share our workplaces, homes, vehicles, clothes, and bodies, the industry is mulling over security. Hmm, what if a cyber criminal intercepts the device? Or seizes control of it? Maybe we'd better do something about that!

Security, like ease of use, is often an afterthought. Making a secure product takes more time, requires more expertise, and costs more money. But if a breach is severe enough to clobber sales and force a company to take expensive remedial action, poor security can cost more money in the long run.

It's bad enough when a phishing email plants a keylogger on your PC that grabs your banking password and raids your account. Or when a network intruder pwns a webcam or baby monitor and spies on your household. But what if someone hijacks your car's cruise control or feeds false input to an implanted medical device?

Fortunately, the companies that make microcontrollers and IoT processors realize they're the first line of defense. Their role is vital. No system can be truly secure without first securing the processor. Also, many IoT products are coming from start-up companies that typically lack the resources to build secure systems on their own.

The two main threats are intercepted communications and system intrusions. Good authentication and cryptography can keep communications secure. Strong crypto usually requires hardware assistance, but a full-featured crypto engine inflates the chip's cost and power consumption. That's why CPU architectures are sprouting new instructions that can accelerate crypto software while adding only a little hardware.

> Injecting malicious code into an automobile or medical device could actually kill someone. And the compromised system needn't be a critical controller.

System intrusions are a bigger threat. Injecting malicious code into an automobile or medical device could actually kill someone. And the compromised system needn't be a critical controller. What if your dashboard GPS advises a wrong-way turn onto a busy one-way street? That's why most processors include hardware that protects vital software. Some systems run two identical processors and constantly compare their outputs—an expensive safeguard that's becoming cheaper.

Another important technology is secure boot, which ensures a system can restart from a known good image of the OS and firmware. This capability is vital for field upgrades that remotely install firmware patches. No matter how carefully a system is designed, hackers may eventually find a hole. Also, evolving security standards require updates. Secure boot enables a networked device to reliably install patches and reboot into a clean state.

Tamper proofing is another rising technology. Processors in mission-critical systems can detect when someone tampers with their enclosure, then take defensive measures. Sometimes those measures include silicon suicide, when the chip blows its own circuits to destroy secrets or foil a takeover. This may be too extreme for a consumer product, but maybe not for a smartcard that's the key to your bank account.

Security may not be sexy, but your life could soon depend on it.

Often the tech industry gets too much credit. Remember, this is the industry that's taken almost 20 years to figure out a reversible USB connector is a good idea. But sometimes the white hats outsmart the black hats, at least for a while.

Tom Halfhill was formerly a senior editor for *Byte* magazine and is now an analyst for *Microprocessor Report*.

CyberPower recommends Windows.

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Thomas L. McDonald

GAME THEORY

Needing Net Neutrality

DO GAMERS NEED TO BE CONCERNED with net neutrality? Let me answer that with a question: When was the last time you bought a game in a box rather than from Steam? Downloaded a patch? Played online? Consider this: When a new *Dota 2* patch goes up, claims Gabe Newell, it accounts for 2–3 percent of global Internet traffic, including mobile.

In comparison, when looking at the stats for North American fixed-line traffic, compiled by Sandvine, Netflix has a 34 percent share, with Amazon accounting for 3 percent. So yes, net neutrality matters to gamers, but the current ruling from the FCC, and the opposition to it, are both wrong.

Opponents of net neutrality say that Comcast, Verizon, and other providers are no danger to the open Internet because the market will provide correction. This isn't the common-sense conservatism I believe in. It's more like a quasi-religious free-market fundamentalism. The providers are functional monopolies for most consumers. The market alone cannot ensure an open Internet.

There is a place for simple rules that guarantee unfettered access. And the rules proposed by the FCC *are* simple. They ban paid prioritization, blocking, and throttling. These are things we should support. They would prohibit fiascoes like we saw last year, when Verizon and Comcast allegedly throttled Netflix, supposedly in a bid to up payments from the streaming service, while also encouraging customers to upgrade to better plans. Comcast, which has seen quarterly profits in the $2 billion range, is arguably milking both ends of the cow.

People, meanwhile, want their rules. And they're not going to let the law get in their way. The FCC doesn't have the authority to do what they're doing. The courts already ruled on that. They cannot make rules for an "information service," only for a "telecommunication service" functioning as a common carrier.

So, what did the FCC do? Redefine the Internet as a telecommunication service. Never mind that the existing law defines an information service as something "generating, acquiring, storing, transforming, processing, retrieving, utilizing or making available information via telecommunications."

Worse, in doing this they have to ignore vast swathes of the law they're invoking, further proof that the existing law wasn't made for this issue. Unfortunately, the political process has become so sclerotic that passing compromise legislation is almost inconceivable.

Gamers are at the leading edge of technology, and if the ISPs can dictate our usage, expect unpleasant results. Data caps, latency issues, and plain ol' throttling will either degrade the experience or raise the cost.

Of course, there will probably be exemptions for services owned by the ISPs. This isn't hypothetical. AT&T owned a piece of the now-defunct OnLive Game Service. Imagine it being exempted from data caps, fees, and throttling while, say, Steam was choked off. That's not a problem the marketplace can solve. We need net neutrality done the right way.

Thomas L. McDonald has been covering computer gaming for over 25 years.

> If ISPs can dictate our usage, expect unpleasant results. Data caps, latency issues, and plain ol' throttling will degrade the experience or raise the cost.

Dota 2's huge traffic shows why gamers should care about net neutrality.

THE LIST

9 NEW PIECES OF STEAM HARDWARE

9 STEAM CONTROLLER

Imagine an extremely customizable Xbox 360 controller with two touchpads. It will retail for $50.

8 STEAM LINK

For $50, you'll be able to use this little device to stream games from your desktop PC to your HDTV at 1080p/60fps.

7 ZOTAC STEAM MACHINE

Zotac's tiny system will retail for $1,000 and is home to a mobile Core i3 and a GTX 970M GPU.

6 ALIENWARE STEAM MACHINE

Starting at $479, Alienware's box is one of the cheaper and smaller options.

5 ASUS GR8S STEAM MACHINE

Asus's tiny Steam Machine starts off at $700 with an i5 CPU.

4 IBUYPOWER'S SBX

Starting at $459, this includes an Athlon X4 840 CPU and a Radeon R7 250X GPU.

3 OMEGA STEAM MACHINE

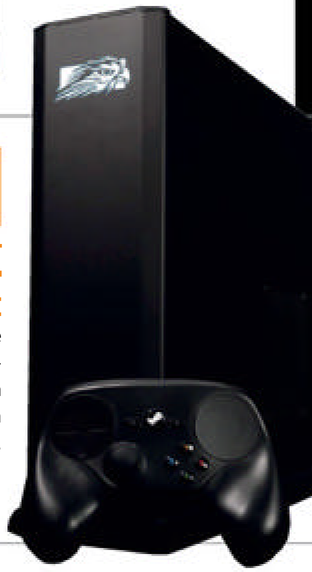
Origin PC's box runs the high-price gamut, starting at $900 and climbing to $5,000!

2 SYBER STEAM MACHINE

This PC starts off at a relatively affordable $500 and scales up to $1,400.

1 FALCON NORTHWEST TIKI

This Steam Machine caters to the high-end enthusiast, with prices ranging from $2,000 to $5,000.



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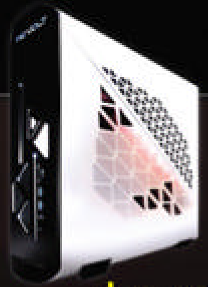

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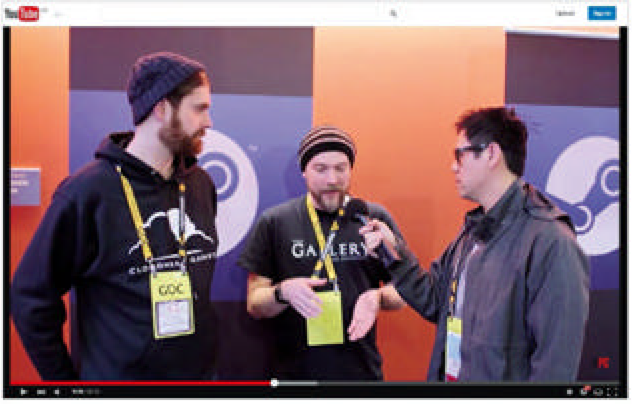
TALKING

Virtual Reality Comes to Life on the PC

How developer CloudHead is helping gamers get a grip on VR tech in more ways than one

The big news at the Game Developers Conference was Valve's Steam VR tech. Valve is the driving force behind the platform and the hardware. But it will be the wider community of developers who turn that into radical new game experiences, developers like CloudHead Games, a specialist in VR interactivity even before Steam VR turned up. We caught up with CloudHead's Denny Unger and Joel Green for an exclusive insight into their *The Gallery: Six Elements* demo. It's an impressive glimpse of the coming VR revolution…



Steam VR is the VR dream realized, the Holodeck itself, according to CloudHead's Denny Unger and Joel Green.

Maximum PC:
Here at GDC, we got an early taste of Valve's VR Experience and arguably the most impressive demo we saw was CloudHead's *The Gallery: Six Elements*. As its developers, can you tell us a little about it?

Denny Unger:
It's a pretty diverse game. It involves exploring "elemental" worlds looking for your sister who's been lost to you. We tried to focus on the roomscale experience and how to bring VR technologies to bear that make for a really interesting experience. We tried to get the player moving around the room and interacting with different objects in a natural way.

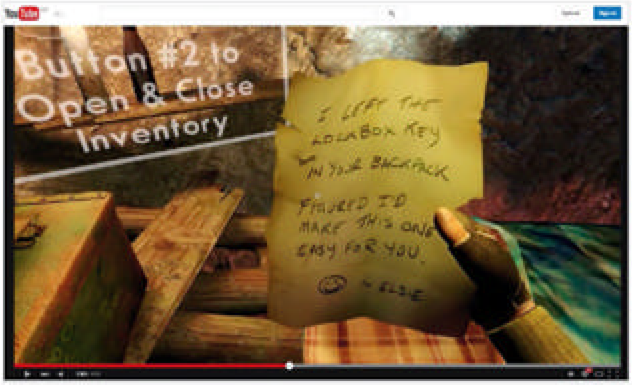
MPC:
Speaking of moving around the room, Valve's VR headset is unique in that it allows you that freedom to physically walk around a virtual environment. It was definitely a little bit trippy but also has us wondering how you will be able to accommodate different room sizes?

DU:
Within the Steam VR SDK, you can define the room dimensions. If you only have, say, a 4-foot by 4-foot play area, you can set that so the system understands those boundaries. Or you could scale it up to 15-foot by 15-foot. However big your room is, you can scale the system to accommodate that.

Joel Green:
Our demo was built specifically for this 12 by 16-foot volume. When the consumer version comes out, everyone is going to have different size rooms. There's more to this puzzle than just having fixed-sized demos. We need ways to move the volume around in the game world and that's what we're working on next.

MPC:
One of the other interesting elements of the demo involves the controller you are using actually appearing in the game. It's something we hadn't previously thought about, but it makes a huge difference to the experience. How's it achieved?

DU:
Steam VR uses lasers and wide-area projection, so the game knows precisely where the controllers are. It's a great system. We built the game originally for Razor Hydra


Button #2 to Open & Close Inventory
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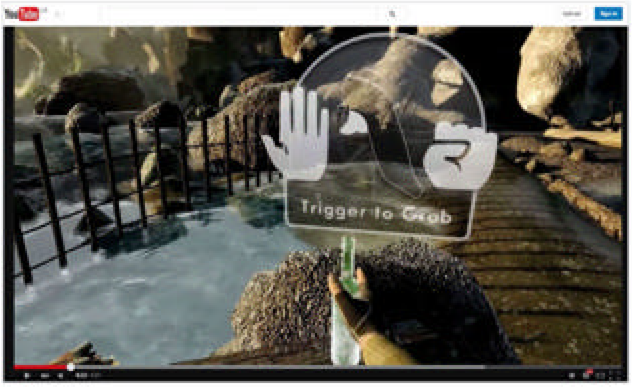
- ELSIE

The ability to manipulate objects just like you can in the real world will be a critical element of VR gaming, says CloudHead.



Laser lighthouses, that can simply be plugged into the wall, are what enable Steam VR's positional tracking.

because that was the only thing we could develop with at the time. It was the best for one-to-one tracking. But this represents tracking tech taken to the next level. It's the dream realized.

JG:
Absolutely. It's the Holodeck. It's what everybody wanted. The fine details of how it's done are a little hard to explain, but the lighthouse boxes are scanning the room constantly with lasers at 60Hz. The headset, the controller or anything else equipped with the right cameras can pick up the lasers and determine where it is in the room. So the positional data is coming from the headset and controller. The lighthouse unit is just a projector. It's not connected to the computer at all.

DU:
Also, you can scatter those lighthouse laser boxes around. If you wanted to use a barn as a VR space, you could scatter these things around and totally do that. Or you can shrink it down and use it at your desk, it's scalable and works the same way.

MPC:
Another really interesting element of the demo experience involves trust in matching game boundaries with real-world boundaries. We were sure the boundaries were accurate, we just didn't feel comfortable walking right out to the limits. We didn't really have that trust in the system.

DU:
The element of trust in those boundaries is something you learn. You learn to trust the system's boundaries are accurate. There's also some interesting technology that hasn't been fully developed yet, like pass-through cameras in the front of the headset and all kinds of possibilities to manage and extend the liability and safety issues. As you move up to the edge of the volume you could use the pass-through camera to see your real room.

JG:
Valve also has a virtual safety net called Chaperone. If you get close enough to a real wall, it shows you a graphical representation of that wall in the game. It's a system that will underlie all games using Steam VR. It's a kind of safety middleware that will be there in any game running in a roomscale environment.

MPC:
Finally, in the demo there's a system for interacting with objects—picking them up, throwing them, it's really intuitive. How important is that kind of interactivity to gameplay in virtual reality?

JG:
One of the major elements in our demo is the interaction system where you can grab the levers and pull things up and down, twist things, or pull things up from the floor. That's a system we've been working on for a long time, since before we were even working with Valve. It's what CloudHead Games specializes in, trying to figure out how interactions are going to work in VR. It's one thing to put on a helmet and stand there looking around. But you want to be able to reach out and touch or grab things. The ability to manipulate things in the virtual world opens up so many game play opportunities.

DU:
You want to be able to meet the expectations that come with being able to move around and see everything on that one-to-one lifelike scale. That really gives you an expectation things are just going to work like they do in real life. So we're building all these systems to accommodate those expectations and that kind of interaction.

Check out the full interview over on the *Maximum PC* website: http://bit.ly/1Exb126

The headset uses"lighthouses" for tracking.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> SSD Migration
> Water Cooling
> GPU Drivers

Feeling Bloated

Doc, I'm looking to upgrade my rig. Currently, the hardware is liquid-cooled. I'm running an Asus P9X79 motherboard, an Intel 256GB SSD, three WD My Book External hard drives and one 250GB WD hard drive, a Core i7- 3930K at 3.2GHz, 32GB of RAM, an EVGA GTX 750 Ti Superclocked graphics card, and a Sound Blaster X-Fi.

Also, I'm using Norton Internet Security and Malwarebytes.

I keep my signatures and scans up to date, but my system hesitates. I don't know what's causing this. I've Reimage Plus and WinZip Driver Updater installed. I keep getting errors from Reimage that the wzdu25.exe files are threats. Neither company is able to help.

The scan on Reimage won't complete. Is there anything you'd suggest?

–Marty Anisko

That's a lot of capable hardware, Marty. There's no reason its performance should be suffering. As far as upgrades go, the Doc sees two subsystems you could balance out a bit. If you're into gaming, that GeForce GTX 750 Ti is limiting your maximum resolution and detail settings. A GeForce GTX 970 or Radeon R9 290 are better matches to Intel's Core i7-3930K. Both are capable of pushing smooth frame rates at 2560x1440, even in the most demanding games. And on the subject of your Sandy Bridge-E-based host processor, it'd probably run well at 4GHz or higher if you wanted to try overclocking. Although additional storage won't improve responsiveness, I can't help but notice the 256GB SSD and 250GB hard drive. Big disks are cheap; adding 3TB for $100 would help clean up the external enclosures.

Onto the software. The Doc is a staunch minimalist. You don't need all those apps. WinZip Driver Updater should be first to go. Nvidia's GeForce Experience utility already tells you when new drivers are available. Chipset drivers are far less common, and the X-Fi won't be receiving any development attention from Creative. Even if this resolves the conflict with Reimage, consider uninstalling that utility as well. Norton Internet Security can be downright intrusive, though the Doc understands antivirus software is mandatory nowadays. If you don't trust your PC to Microsoft Security Essentials, leaving Malwarebytes might be necessary. Meanwhile, the Doc keeps it simple with Windows Defender and cautious habits.

Closed-loop liquid coolers like Corsair's H60 chill effectively without a huge heatsink or the mess of open-loop cooling.

SSD Migration

Hi Doc. I've been a reader for a long time, and am writing about an upgrade for my laptop. I own an HP Pavilion DV7-3024ca, which served me well for years but is sadly not running as briskly as it used to. My first upgrade was 4GB of RAM.

I keep my antivirus software up to date, and I use CCleaner regularly. I've the original Win7 64-bit install on a 5,400rpm hard drive, but the disk has seen better days and I'd like to replace it with a 240 to 480GB SSD. Is there a way to clone the hard drive with its restore partition intact? I watched a few videos, but most suggest using a fresh copy of Windows. I don't have installation media though, just the restore partition and key. Can everything, including those restore files, be cloned onto a new drive? Thanks Doc!

–Christopher Leach

Yes, it's possible to take a mechanical disk and migrate it, sector by sector, to an SSD. Some SSDs even include the necessary hardware/software. If you'd rather not tie yourself to specific bundles, check out Apricorn's SATA Wire 3.0. It's a USB 3.0-to-SATA interface packaged with the company's EZ Gig IV software for $29.

The way it works is simple. Connect your SSD to the SATA side, plug in to the laptop's USB port, run the software to clone all of the information from one repository to the other, and then swap the drives. That's all good if your mechanical disk is the same size. But what if it's larger? EZ Gig, along with other data migration utilities, includes a provision for picking the files and folders to exclude.

To Water Cool Or Not

I recently finished a build I'm fairly pleased with. It includes a Core i5-4670K, Asus Z87-PRO motherboard, 16GB of RAM, a Samsung 840 Pro 512GB,

↘ submit your questions to: doctor@maximumpc.com

Using a simple USB-to-SATA adapter and some software, you can painlessly transition from hard drive to SSD.

two 2x PNY GeForce GTX 780 cards, an Asus Blu-ray reader, SeaSonic's 850W PSU, an NZXT Phantom 410 case, and Cooler Master's Hyper 212 EVO cooler. After modest overclocking, the rig is stable and quiet. However, I want to try water cooling to see how much further I can push it.

Here's what's holding me back. I work for the US Department of State, and I live overseas. I can expect to move every two or three years. A colleague of mine advised against water cooling because he thought it'd be a pain to disassemble when I get relocated. Do you agree? I will tell you that I'm a gamer. Currently playing *The Witcher 2* at 1440p. As I said, I'm pretty happy with my rig.

–Alain DeWitt

The Doc is a gamer as well, Alain. But he's also very busy. That means big air coolers get preferential treatment in his ATX cases, while closed-loop liquid coolers like Corsair's Hydro H60 are easier to fit into the compact machines he builds. Spending extra on a water cooling kit in the hopes of coaxing another 100 or 200MHz from a CPU just doesn't seem practical. In fact, it counters one fundamental goal of overclocking: improve value by boosting the performance of more affordable components.

But many power users swear by water cooling. Some take that route for improved thermal performance. Beefy radiators and pumps aggressively dissipate heat from high-end host processors and graphics cards. Other enthusiasts like the aesthetic impact. It's hard not to be impressed by neatly routed tubing filled with UV-reactive coolant behind a windowed side panel. And believe it or not, water-cooling kits can be easier to transport. Heavy heatsinks strapped to fragile sockets tug on motherboards, warp retention mechanisms, and even pull CPUs out of place.

You asked the Doc's opinion though, so here it is. The Hyper 212 EVO already strapped to your Core i5 represents a great compromise between size and cooling, particularly at its price point. If you're already nursing a reasonable overclock, sinking hundreds into water-cooling hardware will only serve to erode the value of that tuned chip. Why not treat yourself to a couple of extra games instead?

NVMe Disappointment

I recently purchased Samsung's XP941 M.2 SSD during a moment of risky early-adopterness. But I became suspicious of performance issues shortly after assembling my new Asus X99-Deluxe/Core i7-5930K rig. *Far Cry 4* wasn't loading any faster than it did on my Z97/Samsung 840 EVO-based system. Even Word didn't act snappier. Now I read in your April issue that the NVMe party hasn't started yet. Color me depressed. What can I do to maximize the XP941's performance? Could a NVMe-capable firmware flash to either/both components address the problem?

–Chris Ajemian

Although the Doc has heard of issues with the XP941 performing erratically after waking up from a sleep state, he's not aware of any responsiveness issues. A little expectation management may be in order, though. The 840 EVO is a quick SSD. The XP941 boasts incredible sequential throughput, but it won't stand out as prominently from the SATA 6Gb/s crowd as synthetic storage benchmarks suggest.

Early in March, Asus did publish an NVMe-capable firmware for its X99-Deluxe. But the XP941 employs AHCI, as does Samsung's SM951. Until desktop-oriented drives with NVMe support start showing up, enthusiasts are must gawk at the enterprise-class SSDs and drool.

Busted Graphics Card

Thanks to some "help" from my children, my old Radeon HD 6950 graphics card is broken. I'm looking at upgrading to either a Radeon R9 285 or GeForce GTX 960. Since I don't have my old card to boot from, which would allow me to uninstall the old drivers, should I stick with AMD to avoid a headache? I'm running an Asus Crosshair Formula V, with 16GB of RAM, an FX-8150 processor, and Windows 7 64-bit. School is starting soon, so any advice would be appreciated.

–Jonathon Hardin

Let's get you past that driver issue first, Jonathon. Go grab Display Driver Uninstaller at www.wagnardmobile.com. As long as you're able to boot Windows to Safe Mode, the utility will find and eradicate Registry entries, folders, and files related to the existing Catalyst installation. From there, you shouldn't have any problem getting back into Windows. Of course, that's been the Doc's experience. The tool's author takes no responsibility for anything that goes wrong.

Assuming DDU does its job, you're free to choose between the Maxwell-based GeForce or Radeon with AMD's Tonga GPU. The Radeon is more expensive. However, it's available with significant rebates. Both cards are similarly quick.

The Doc thinks Nvidia has the advantage in this battle, though. Its GM206 GPU comes equipped with 1,024 CUDA cores and is complemented by 2GB of GDDR5 memory, making it most suitable for gaming at 1920x1080. But the board is only rated for 120W, meaning it can get away with a single 6-pin power connector. You're already used to the 200W Radeon HD 6950, so this card would kick out less heat (and run more quietly). If you plan to record your gaming sessions, ShadowPlay is proving to be a popular bit of software. And Nvidia's Multi-Frame Anti-Aliasing technology reduces jaggies at a lower performance cost than other techniques.

In contrast, AMD specifies its Radeon R9 285 for 190W, necessitating two 6-pin connectors. Game recording is supported through a bundled third-party app called Raptr, and a recent beta driver gave us our first look at FreeSync, which synchronizes a compatible display's refresh rate to the R9 285's output, eliminating the compromises imposed by V-Sync. Nvidia matches that capability with its own proprietary G-Sync. But both companies' implementations require you buy a compatible monitor.

Nvidia's G-Sync technology is proprietary; AMD's FreeSync isn't. As a result, FreeSync-compatible panels should be less expensive.

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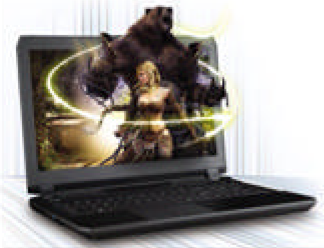

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- 30 days No Dead Pixel Guaranteed Insurance
- 6GB DDR5 NVIDIA® GeForce™ GTX 970M GPU with Optimus™ Technology
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- Optional NVIDIA® GeForce™ GTX 980M GPU
- 8GB DDR3-1600MHz Memory
- 128GB Micron® M600 mSATA SSD + 1TB 7200RPM Hard Drive
- 6X Blu-ray Reader / 8X DVD±R Super Multi Drive
- Full sized Keyboard with color LED backlight
- Intel® Dual Band Wireless-AC 7260 + Bluetooth
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- 8GB DDR3-1600MHz Memory
- 1TB 7200RPM Hard Drive
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- 1 Hard Drive + 1 M.2 SATA SSD Drive or M.2 PCIe SSD Drive capable
- Full sized Keyboard with white-LED backlight
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GPU SUPERSTARS

What graphics card should you plug into your machine and what new tech should we be holding out for?

By Dave James

The shifting sands of the GPU market have changed into something a little less fluid in recent times. For a long while we'd find a new graphics card release every time we fell out of bed in the morning, tripping over press releases and new slabs of reference PCB. These days, however, we're talking about a more glacial pace of product development, especially when we're looking at actual GPU architecture and not just old cards with new badges on them.

That's not necessarily a bad thing though, given the board partners are themselves capable of adding in new features and new SKUs to bolster the native appeal of a particular GPU. The rise of the 0dB cooling array, the addition of extra video memory to the frame buffer, boosted power circuitry, and the classic core clock tweakery all add together to differentiate one manufacturer from the other and one graphics card from the rest.

But still we crave the new. And the length of time between genuinely new GPUs is ever lengthening, and for multiple reasons. Nvidia has actually been relatively good at sticking to its yearly cadence for fresh architectures or designs, though it has been flitting between leading the line with new high-end, ultra-enthusiast offerings and low-end alternatives.

AMD, however, has been far more laggardly about getting new graphics silicon in place. There are still GPUs in the latest range of cards from the big red Texan company that were released at the start of 2012, and as yet we're still to see its new range in anything other than shipping manifests and rumor-mongering.

But there's a lot to be excited about with both what we have available to jam into our PCs right now and what we can be looking forward to over the next six to 12 months.

IceQ X²
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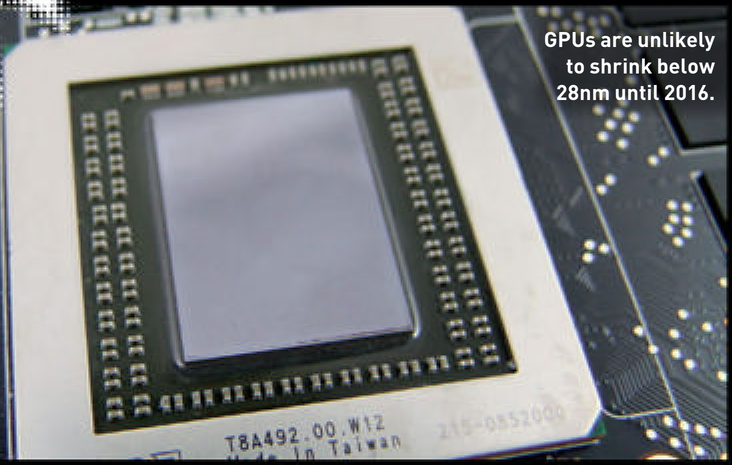


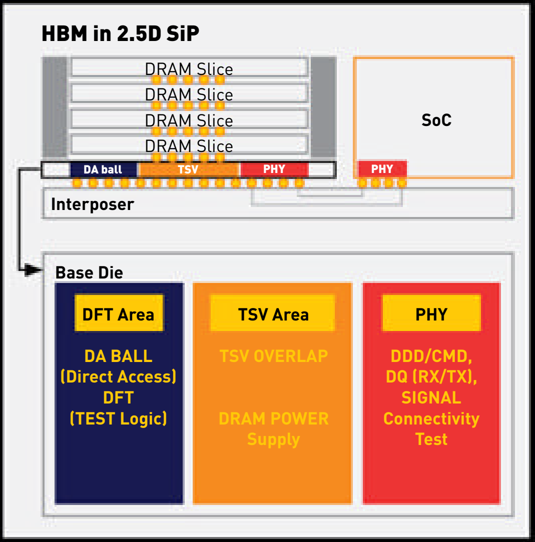
GPUs are unlikely to shrink below 28nm until 2016.

Graphics cards used to be almost immune to the creeping mobile disease that had been holding back the central processing unit. Where the CPU was starting to be designed with a mobile-first strategy in mind—being beefed up slightly to make for a decent desktop offering, sacrificing raw processing grunt for power-efficient functionality—the GPU was always this enormous chip with little-to-no thought given to the power needed to get the damn thing running or the heat that it was continually producing.

Graphics cards got bigger as the silicon bloated. Single slot options all but vanished. And the power and cooling demands got ever more outlandish and, eventually, became mostly unsustainable.

Over the last few generations though, the marketing money has increasingly gone into educating us all about the performance per watt improvements that successive GPU architectures have achieved.

AMD's Fiji will be the first GPU with High-Bandwidth Memory (HBM).



Thankfully, the processor guys have suffered all the trials of the search for performance efficiency so that our graphics cards don't have to. That means we're still getting improved GPU performance, generation-on-generation, but we are also seeing power draw and temperatures continue to drop.

Nvidia has been the one leading the charge here in the PC sector. First with the Kepler architecture improving on the hot mess the top-end Fermi cards had become, and then with its current marvelous Maxwell architecture. The latest design has been set up so that it can scale from the very small all the way up to the professional class super-computer chips.

RED DAWN?

So what has AMD been doing? Not a lot. Just take its latest top-end GPU, the Hawaii chip released in the dying light of 2013. It's probably a coincidence it was code-named after a volcanic island, but the super-heated, massive GPU ran at a frankly crazy 93 C under load with the reference cooling design from AMD. And it was designed to run at that speed according to the AMD people we questioned at the time too, as our test rig started to glow white hot...

Its last new GPU, the Tonga chip in the R9 285, is the first of the Graphics Core Next raft of silicon to actually make proper strides in the pursuit of improved GPU efficiency. Dropping the TDP of the equivalent R9 280 down from 250W to 190W, it's still been able to maintain performance while drawing less power and generating less heat too.

That's still a lot higher than the TDP of Nvidia's latest top-end consumer GPU, the GTX 980, which has a thermal design point of just 165W. So, how come Nvidia has been able to make such strides before AMD and why are we still waiting on its competing graphics architecture to give Maxwell a run for its money?

You have to look back a little way to get to the bottom of this. AMD was in fact ahead of its time when, generations ago, it took the gamble of focusing on smaller GPU designs with lower power draw. It chose to cede the top-end of the graphics market to Nvidia's increasingly large and hot chips. Instead it tried to use dual-GPU designs to compete at the high-end where such efficiency concerns could be ignored.

Then it got all excited about the performance of its newer architectures, getting caught up in the battle for the biggest top-end numbers, abandoning its initial impulse, and producing ever bigger and more power-hungry GPUs once more. Nvidia, meanwhile, suddenly switched tack with the Kepler designs, and AMD was left not knowing which way to jump.

LITHE LITHOGRAPHY

Now, to really hit the efficiency figures it needs to with the existing GCN architecture AMD is intent on sticking with, the company needs to get its silicon onto a smaller, less power-hungry production process. Last year we were expecting to move down to 20nm, which would allow for smaller chips generating less heat. But problems with production, performance, yields, and the cost has made it unlikely we'll see a 20nm GPU even this year.

There's still faint hope the new Fiji GPU in the upcoming Pirate Islands range will be produced on the 20nm process, but even that might turn out to be wishful thinking. The fact we're still waiting on its release this far into 2015 suggests AMD may be committed to waiting it out. We sure hope so. The big news for the Fiji GPU though is that it's going to be the first GPU to be sporting High-Bandwidth Memory (HBM). Well, that and the fact it's expected to be rocking some 4,096 streaming microprocessors—it's going to be one sizable chip if AMD can't hit 20nm. Hell, it's going to be massive even if it can. The collaboration between Hynix and AMD though has produced a stacked version of the frame buffer, in a similar way to the V-NAND in Samsung's 850 SSDs, which will allow for a huge amount of bandwidth.

Arranged around the GPU, rather than actually on top of the graphics silicon, HBM is able to offer a significant amount of bandwidth, a massive 640GB/s in fact. That's almost double what's on offer with Nvidia's new Titan X (see page 78). At the moment the memory is arranged in four 1GB stacks, each delivering a 1,024-bit bus. That makes for an enormous, aggregated 4,096-bit bus, and implies the actual memory speed is slower than standard GDDR5, again similar in the way Samsung has used older memory tech in its V-NAND. The second-gen version of HBM is set to go even further, offering up to 8GB and 256Gb/s of bandwidth per stack.

The rest of the Rx 3xx series of graphics cards are likely to be only slightly tweaked versions of the same 28nm GCN GPUs we've got in the current lineup. The Tonga GPU looks to be getting a rebrand as the R9 370 and 370X, with the lower-end part being similar to the R9 285 and the higher-end one being the R9 285X we were expecting last year. The R9 380 and R9 380X are likely to be mildly modified versions of the Hawaii chips from the top-end cards of the previous gen, despite sporting new GPU code-names of Grenada.

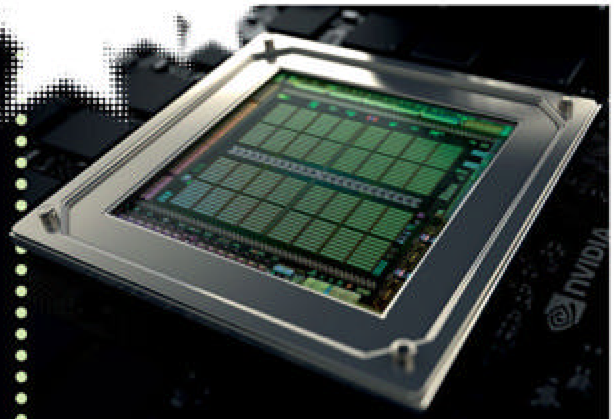
BLAISE OF GLORY

Looking further afield, Nvidia will be joining in on the stacked video memory fun in 2016 with its Pascal GPU architecture. It will feature a similar kind of memory as the R9 390X in that it's arrayed around the GPU rather than directly on top of it, but is also going to introduce a new interconnect between CPU and GPU called NVLink. The new fatter pipes are expected to deliver up to 80GB/s of data compared with the 16GB/s we've got in today's systems.

So, if that's the past and the future of our graphics cards, how do things stand today? We've brought together the current generation of GPUs in the following pages to see how the best gaming silicon of today stacks up against each other.

Nvidia CEO Jen-Hsun Huang announcing Maxwell successor Pascal.

I'm out of my mind excited about it—Jen-Hsun Huang talking about NVLink.



The Great Green Memory Conundrum

WHEN COMMUNICATIONS BETWEEN TECH MARKETING AND ENGINEERS FAIL, A GRAPHICS CARD SUFFERS

It would be remiss of us to talk graphics tech without mentioning the recent controversy surrounding Nvidia's GTX 970 GPU and its "miscommunicated" technical details. Something happened between the engineers and the technical marketing team because the launch specs of the GTX 970 came out all kinds of wrong.

Originally we were told the basic configuration of the GM 204 GPUs in both the GTX 970 and GTX 980 only differed in terms of the CUDA core count, with them having the same 104 texture units, 64 ROPs, 2MB L2 cache, 256-bit bus, and 4GB GDDR5 memory. Some parts of that official spec are plain wrong. Some are mightily misleading. Importantly, the GM 204 inside the GTX 970 actually only contains 56 ROPs and 1.75MB L2 cache.

That mistake is largely forgivable as it doesn't really affect the way the card performs—it was already behind the GTX 980 on that count anyway. The bigger issue is that 4GB frame buffer. It came to light that the GTX 970 was reporting only 3.5GB before tapping out in scenarios where the GTX 980 would go all the way to 4GB.

It turns out the memory systems on these two Maxwell cards are very different, something linked into those shut-off ROPs. Nvidia segmented the memory on the lower tier card into a 3.5GB chunk and an extra 512MB block, but the larger block has a full 192GB/s of theoretical bandwidth, while the smaller is running at just 28GB/s. That means if a game runs over the 3.5GB portion of frame buffer, performance will drop drastically because the access time is much slower. It's not quite as slow as when you go over 4GB on either of these Maxwell cards as it's still faster than the 16GB/s bandwidth over the PCIe connection to the system memory.

Realistically the GTX 970 hasn't been designed for the sort of high-res situations where this is typically an issue, but as more texture data is used by games, that 3.5GB portion is going to find itself exceeded. Why it's really an issue though is the fact Nvidia didn't communicate any of this until it was caught by enthusiasts testing their own cards. This doesn't suddenly make the GTX 970 a bad card, but it makes the market a bit wary moving forward.

Nvidia GeForce GTX 980

The more affordable mighty Maxwell

UNTIL THIS MONTH, Nvidia's GTX 980 was the top single-GPU graphics card around. And then the inevitable happened. The green team dropped the full force of its GM 200 Maxwell core in the form of the GTX Titan X. We've gone into detail on the new ultra-enthusiast card on page 78, but suffice to say it's the new GPU performance king.

At nearly $1,000, however, it's beyond the reach of most of our bank accounts, which is why it and the R9 295X2 aren't included in this supertest. So we're concentrating on cards you're actually likely to buy, rather than just dream about. Still, the GTX 980 is no budget option. Prices start at around $550, with some manufacturers offering versions for another $100 or more.

The GTX 980 is still one hell of a gaming graphics card though. It may not hit the same levels of 4K gaming as its Titanic big brother, but it really doesn't do badly. This card is hitting some 36fps in *Battlefield 4* at 4K Ultra, and 34fps in *Shadow of Mordor* at the same graphics settings.

But having spent a lot of time with 4K monitors, anything below 40 inches just feels too small and you're really paying a severe performance price. So we're still more than happy with our 1600p and 1440p screens, and at those resolutions, the GTX 980 is an absolute monster. Throw it on to a super-wide 34-inch 21:9 panel too, and it just flies in whatever game you throw its way.

PRICE WARS

This Maxwell card though is caught in a battle with AMD's Radeon R9 290X. Because there's been such a long time between its launch and the release of the upcoming Pirate Island, R9 3xx series, the prices of current-gen AMD stock have nose-dived like they were piloted by Harrison Ford himself. The AMD card opposite is now $200 cheaper than this impressive GTX 980, and isn't *that* far off in terms of 1080p or 1600p performance.

You can though pick up GTX 980s with funky 0dB cooling arrays, where the fans only start spinning when the GPU hits a certain temperature. It also runs with a good chunk less power than the Radeon.

We also have to talk about the Nvidia ecosystem as a whole. When it released the GTX 980, Nvidia came out with a set of interesting techniques to get either more performance or more visual fidelity from our games. Dynamic Super Resolution (DSR) allows you to run at higher resolutions than your monitor can produce by rendering at that high level and shrinking it down to fit your screen. For games with performance to burn, such as *GRID 2* in our suite of tests, that adds a little extra quality while still delivering the performance.

On the flip side, where you're struggling for speed, there's Multi Frame Anti-Aliasing (MFAA), which can produce 4x levels of antialiasing with the performance hit of only 2x. Then there's Voxel Global Illumination (VXGI), the cheating pseudo ray-tracing tech just included in the current custom branch of Unreal Engine 4.

At the current price though it's tough to look past the R9 290X bargain. In those Sapphire clothes it's cool and quiet and blazes through 1080p and 1600p benchmarks. The GTX 980 is just a little too expensive for the relatively small performance boost it offers right now.

SPECIFICATIONS

GPU	Nvidia GM 204
CUDA Cores	2,048
Memory Capacity	4GB GDDR5

VERDICT
8

Nvidia GeForce GTX 980

JETSTREAM Great gaming performance; 0dB cooler options; bulging ecosystem.

WETSTREAM Still seriously expensive.

$550, www.newegg.com

Sapphire R9 290X Tri-X

Clearing out the speedy old stock

WITHOUT A NEW GPU IN SIGHT, AMD inevitably has to fight the good fight on pricing these days. The big, powerful Hawaii XT GPU inside this R9 290X is a complex ol' graphics processor and must cost a few bucks to produce in numbers. And that's why at launch it was the same price as the GTX 980 is right now.

Some 18 months later we're gearing up for a summer launch of AMD's next generation of graphics cards—including a reworked Hawaii XT appearing with a new badge—and Nvidia has just unleashed its massive Maxwell card. With stock still in the channels, prices on older AMD cards have drastically dropped. That means this Sapphire version of the R9 290X is a stunning $350.

The first, reference edition of the 290X we tested was a roaring hot mess, delivering great gaming performance, but running at a molten 95 C when pushed in-game. Thankfully AMD has some great partners like Sapphire, who were able to turn the 290X into a card you'd actually feel safe enough to drop into your own machine. You know, without worrying it was going to spontaneously combust during an intensive round of *Peggle*.

The Tri-X chiller on this Sapphire R9 290X is fantastic, cutting that 95 C peak temp down to just 71 C—cooler than the GTX 980 with its efficient Maxwell GPU. And it's also remarkably quiet when it's working away too, those three fans never hitting the roaring blast the reference chip chiller shouted out.

GOT GAME?

Performance-wise, it's obviously behind the GTX 980. But neither card is a real 4K gaming GPU on its own anyway, so you're looking lower down the resolution scale to 1600p, 1440p, or 1080p. And at that scale the 290X delivers high enough frame rates that the performance difference between it and the GTX 980 becomes almost inconsequential. The Nvidia card does, however, offer higher minimum frame rates across the board. That means you'll be getting a smoother gaming experience with the GeForce option.

But you're going to have to pay for that privilege, and when you're looking at a good $200 more than this Sapphire 290X, that makes it a much tougher ask. If you can afford the GTX 980, that's the better card. This Sapphire's current cost, however, makes it the smarter purchase for the more price-conscious PC builder.

The R9 290X isn't the only AMD card to have seen a hefty price drop. The R9 290 is so close to the 290X that it's mighty tempting too. It's still rocking a full 4GB frame buffer and, because it's still the Hawaii GPU, it's running across an aggregated 512-bit memory bus. But given the pricing is so close, this Sapphire 290X remains the champ performance-for-price GPU right now.

Nvidia will keep shouting about the extras it offers, and with GeForce Experience offering a better... well... experience than the bought-in Raptr setup, it's tough to argue. But when we're talking value, the aging AMD cards still have a lot to give at this price. Just make your move now. When the supply in the channel runs out, those prices aren't going to last.

SPECIFICATIONS

GPU	AMD Hawaii XT
GCN Cores	2,816
Memory Capacity	4GB GDDR5

VERDICT 9

Sapphire R9 290X Tri-X

⊞ **HAWAII** Serious gaming speeds; cool and quiet; great price; hefty memory configuration.

⊟ **ALCATRAZ** Not quite as quick as the GTX 980; trades performance blows with GTX 970.

$350, www.sapphiretech.com

Gigabyte GTX 970 G1 Gaming

Much maligned, but still standing

THE POOR OL' GTX 970 has taken a pounding since the nightmare that followed its release. It seems the engineering team hadn't communicated the smart work it had done in splitting up the cache. That meant Nvidia's marketing bods got confused, thought it had basically the same GPU and memory layout as the GTX 980, and ended up misleading everyone.

And then it came out. And the Internet got all kinds of grumpy. It's a real shame. If Nvidia had communicated what it had done, we'd have been impressed it'd kept hold of essentially a 4GB frame buffer through some unprecedented tech goodness, even if it was split between a speedy 3.5GB bit and a slower 512MB part.

The performance problems only really start when you fill up that 3.5GB portion. And those are situations the GTX 970 was never really meant to get into. *Shadow of Mordor* is the only current game which tops that with its HD texture pack—it hits 5GB at 1600p Ultra settings, which would mess up any GPU except the Titans.

So don't believe the hype. The 970 is still a great card. That's especially true with this outstanding Gigabyte version. The triple fan array keeps it super chilled at just 58 C under load and the gaming performance can often push an overclocked R9 290X into second place. The AMD card though has the better memory bus, so operates quicker at high-res and at the moment is cheaper. But it's a mighty close run thing between these two quality cards.

SPECIFICATIONS

GPU	Nvidia GM 204
CUDA Cores	1,664
Memory Capacity	4GB (3.5GB & 512MB)

VERDICT 8

Gigabyte GTX 970 G1 Gaming

⊞ **G1** Excellent cooler; great overclocking performance; speedy gaming.

⊟ **1D** Rage-filled memories of miscommunication.

$350, www.gigabyte.com

XFX R9 290 Black OC Edition

In a Hawaiian no-man's land

WITH THE RECENT AMD PRICE CUTS trying to shift existing stock before the new generation drops, plus take the sting out of the Titan X launch, its graphics card stack has been mightily squeezed. It's more obvious with the three R9 28x cards below this R9 290, but it's still getting tricky for the second-tier Hawaii card to make a name for itself.

The issue is the R9 290X now costs just $350. That's only around $45 more than this XFX OC Edition card, leaving the poor ol' R9 290 in a bit of a no-man's land. It's a lot more expensive than the R9 285 and can't quite catch up with its big Hawaiian brother. Granted the relative performance stats of the two Hawaii GPU-powered cards are incredibly close, but we'd still recommend spending that little extra on a definitely superior slice of silicon.

It also helps that the Sapphire card is so quiet despite the roaring, 2,816-core beast smouldering away under that cooling array. But XFX's dual-fan design is still good. The stylish-looking shroud keeps the Hawaii Pro GPU to the same 71 C maximum as the Tri-X cooler manages.

None of that really helps when there's almost no real place for this capable card right now. That might change though as availability of the cheaper R9 290X drops off as the supply line runs dry in preparation for the Hawaii GPU to get respun as the R9 380 and R9 380X. But until then we'd still recommend spending your cash on the excellent R9 290X if you're in the mood for a good value GPU upgrade.

SPECIFICATIONS

GPU	AMD Hawaii Pro
GCN Cores	2,560
Memory Capacity	4GB GDDR5

VERDICT 8

XFX R9 290 Black OC Edition

⊞ **SUPER COOL** Good gaming performance; sleek shroud; quality cooling.

⊟ **PITY THE FOOL** Everything else about it.

$306, www.xfxforce.com

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HIS R9 280X IceQX2

Are you still here?

THERE'S SOMETHING ODD about the R9 280X. There's also something old about it. That's the Tahiti XT GPU at its heart. This card is essentially the Radeon HD 7970 GHz Edition from three years ago. We'll let that sink in. Three years. It goes to show the slow progress AMD graphics tech has made. But also how capable its GCN architecture has been. The fact it's still decent is incredible.

But this card should've been put out to pasture, replaced by the R9 285X, with its Tonga XT GPU. And where is that card? It's maybe still stuck in engineering hell because the Tonga GPU struggled playing nice with Mantle, possibly because of its changed memory system and funky new memory compression algorithms.

So the 280X is still here and still on sale. Unfortunately the pricing on it hasn't changed to reflect the market, meaning this anomalous HIS card is priced higher than the much quicker R9 290 from XFX. And because the Tahiti GPU is old school GCN, it's missing out on the goodness of the later silicon. Most tellingly it doesn't have any support for AMD's new frame syncing technology, FreeSync.

If you're already sitting on an R9 280X, don't panic. Even though it's a 3-year-old card, its high-end memory configuration, with 3GB running over an aggregated 384-bit bus, means it's still very capable at both 1080p and 1600p. But you should look elsewhere if you're thinking of upgrading—there's no value to buying a 280X anymore.

SPECIFICATIONS

GPU	AMD Tahiti XT2
GCN Cores	2,048
Memory Capacity	3GB GDDR5

VERDICT 6

HIS R9 280X IceQX2

+ **XT** Well-specced GPU and memory; decent gaming performance.

− **ATARI ST** Old-fashioned tech; power-hungry; lacks FreeSync support; expensive.

$280, www.hisdigital.com

Sapphire R9 285 DualX

Making the right cuts

THE R9 285 IS AMD'S MOST RECENT graphics card. Its Tonga GPU is the most modern GCN architecture around, utilizing a similar memory compression algorithm to Nvidia's latest Maxwell chips. That means AMD has got similar effective memory bandwidth levels through more conservative buses and memory configurations.

As such, the R9 285 comes with a 256-bit bus and a 2GB frame buffer compared with the R9 280's 384-bit bus and 3GB frame buffer. For the most part that doesn't make much difference. They're within a few frames per second of each other in most gaming benchmarks. They're also a similar price. But the 285 does give you access to things like AMD's TrueAudio Technology and FreeSync.

But, achieving parity in *most* of our benchmarks? Well, where they don't is telling. The 280 posts slightly improved scores playing *Battlefield 4* via DirectX 11, but is much better in our top-end *Shadow of Mordor* test. That's a benchmark that thrives on memory performance. It highlights where the newer chip and its cheaper memory subsystems are failing. The issue is that this is where game engines are heading—the R9 285 is going to struggle in the future of VRAM-intensive gaming, even at 1080p.

This Sapphire card could be in trouble. For now its $250 price tag makes it a great card, but you have to weigh up whether you need FreeSync or whether you want the ol' 280's memory setup. Tough choices.

SPECIFICATIONS

GPU	Tonga Pro
GCN Cores	1,792
Memory Capacity	2GB GDDR5

VERDICT 7

Sapphire R9 285 DualX

+ **TONGA** Decent current-gen gaming speed; FreeSync and TrueAudio support; great price.

− **TONKA** Weaker memory setup; will quickly become dated.

$250, www.sapphiretech.com

Asus STRIX GTX 960

Cool, quiet, and ornithological

THE GTX 960 IS ALMOST IDENTICAL to the R9 285 in so many ways. They are priced similarly, they perform almost identically in our gaming benchmarks, and they both have the same memory issues.

Nvidia's GM 204 GPU saw it working with some new compression algorithms. This new technique allows it to use a small memory bus and still retain a relatively high effective memory bandwidth. The GTX 960 then has a 2GB frame buffer running across a lowly 128-bit bus, which delivers some 112GB/s of bandwidth, though with the new compression jazz in place it estimates that to transform into 149GB/s effective.

That makes sense from a manufacturing point of view—the 128-bit bus is obviously cheaper to make than that double-width 256-bit bus on the GTX 760 this card is replacing. But that doesn't help us gaming types. More titles are demanding extra frame buffer capacity to deliver the highest performance. Suddenly, adding extra gigabytes to the VRAM allocation is offering higher fps.

Again, it's *Shadow of Mordor* highlighting what's in store. Both the GTX 960 and R9 285 fall behind the geriatric R9 280 with its 384-bit bus and 3GB frame buffer. But it's still a tough choice. We wouldn't recommend anyone upgrading to a 3-year-old GPU, so the R9 280 is right out. At this price it's all down to who's cooling, ecosystem, and drivers you trust more. The STRIX is practically silent, cool, and not so thirsty, and we do so love GFE...

SPECIFICATIONS

GPU	Nvidia GM 204
CUDA Cores	1,024
Memory Capacity	2GB GDDR5

VERDICT 8

Asus STRIX GTX 960 OC Edition

⊞ **STRIX** Super-chilled; almost silent; small; good 1080p performance.

⊟ **STRUCK OUT** Weak memory system; not future-proofed.

$210, www.asus.com

Powercolor R9 280 TurboDuo

Help the aged help themselves

THE R9 280, with its ancient Tahiti Pro GPU, is like that old man you find in small town nightclubs. The girls laugh and dance with him in mocking amusement and yet he refuses to pass quietly into the night. Except in this case, the old man would be taking one of those girls home and showing her that with age comes experience...

The R9 280, like the 280X, is a 3-year-old graphics card. It was the old HD 7950, a top card of its generation, meaning it's still got a beefy memory bus and a healthy 3GB frame buffer. So, even though it's looking kinda dated—it doesn't have the latest GCN architecture's new feature set—it's still got the raw GPU horsepower and componentry to power its way to impressive gaming performance. Unlike the 280X though it has a much more reasonable price tag. It's priced $40 below the R9 285, making it a very affordable card which allows you to almost hit 60fps at 1080p Ultra settings in *Battlefield 4.* It smashes the 285 and the GTX 960 in *Shadow of Mordor.*

So, it's still a good card and this mighty affordable Powercolor version comes with a quality cooler keeping things nicely chilled and quiet. If there's one in your current rig, and you've got some PSU headroom, grabbing another for a CrossFire setup would give you great performance for a relatively minimal outlay. But if you're looking for a new single card upgrade, we still can't recommend 3-year-old hardware, especially if FreeSync is playing on your mind like it is ours.

SPECIFICATIONS

GPU	AMD Tahiti Pro
GCN Cores	1,792
Memory Capacity	3GB GDDR5

VERDICT 7

Powercolor R9 280 TurboDuo

⊞ **TURBO** Good 1080p gaming performance; quality memory setup; cool and quiet.

⊟ **TURN OFF** Outdated feature set; power hungry.

$210, www.powercolor.com

XFX R9 270X

Suffering the squeeze

AT $200, THE R9 270X is pushing towards the budget market, but with the midrange and high-end of AMD's current graphics stack seriously compressing, this poor little GPU is really feeling the squeeze. When the R9 285 is only a night's bar tab away and yet is a far more powerful and advanced graphics card, there's no decision to make.

We're once again talking about a GPU only rocking the first iteration of AMD's GCN architecture too. No TrueAudio, no memory compression funk, and not even a sniff of the FreeSync tech. That adds up to an unappealing card but one that demands a surprising amount of power.

The squeeze isn't just coming from a cascade of higher-performance cards either. Nvidia's Maxwell architecture started at the bottom of the market in the GTX 750 and GTX 750 Ti and that surprisingly capable GM 104 GPU really pushes the R9 270X in terms of gaming performance. And costs a good deal less. At this end of the market, being $60 more means a lot. It represents a hefty 40 percent price difference between them.

This is the real problem with the GCN architecture. It works at the high and midrange, where you can get away with being power-hungry and generating a bunch of heat, but at the low end it still needs a lot of power. Maxwell on the other hand has been designed to scale from tablets up to supercomputers and so is far more efficient. XFX's cooling array does its best, keeping things chilled, but can't help the power draw or performance.

SPECIFICATIONS

GPU	AMD Curacao XT
GCN Cores	1,280
Memory Capacity	2GB GDDR5

VERDICT **5**

XFX R9 270X Double Dissipation

⊞ **POWER PLAYER** Quality cooling array.

⊟ **POWER HUNGRY** Disappointing performance; last-gen tech.

$200, www.xfxforce.com

Zotac GTX 750 Ti

The great equalizer

THE GTX 750 TI might go down as one of our favorite-ever graphics cards. It represented a shift in Nvidia's scheduling, being the first GPU running on its new Maxwell architecture, but being resolutely low-end.

It was almost like Nvidia saw the writing on the wall regarding the 20nm process transition and was testing how efficient it could get its new architecture on the 28nm lithography before committing its top cards. Almost.

But none of that is why we love the GTX 750 Ti so much. Its real beauty is that it's so low-powered—100W lower peak platform power compared with the closest AMD GPU—and yet still delivers excellent 1080p gaming. We were able to cobble together a passively cooled option which didn't even throttle back its clock speed.

This Zotac version is good. It delivers the necessary gaming performance and does it all cool and quiet, but still demands a PSU power connector. Our favorite GTX 750 Ti cards though take all their power from the PCIe socket itself, making them one-shot upgrades for even that $400 desktop you picked up from Best Buy. Just $140 later and you've got a 1080p gaming machine without needing any other upgrades.

It's the great equalizer. The GPU that can make every PC a gaming PC and for an absolute bargain price. Bless the little GTX 750 Ti. We'd say it's actually more important to PC gaming than the new GTX Titan X.

SPECIFICATIONS

GPU	Nvidia GM 104
CUDA Cores	640
Memory Capacity	2GB GDDR5

VERDICT **9**

Zotac GTX 750 Ti

⊞ **MUAY THAI** Stunningly efficient; impressive gaming performance; great price.

⊟ **BYE BYE** This Zotac version does need a 6-pin power connector.

$140, www.zotac.com

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HOW WE TESTED

Our GPU test rig is a stock-clocked Core i7-4770K in an Asus Maximus VI Hero Z97 board with 8GB DDR3 running at 1,600MHz. All of our graphics cards are tested with the latest release drivers on the same benchmark settings to ensure a fair test. We've included all the minimum frame rate results as well as the overall average to indicate how smooth an experience you're getting from each graphics card.

SPECIFICATIONS

	Website	Price	GPU	Cores	Memory Capacity	Memory Bus	Peak Platform Power	Peak Temperature °C	Score
Nvidia GeForce GTX 980	www.nvidia.com	$550	GM 204	2,048	4GB GDDR5	256-bit	292W	80	8
Sapphire R9 290X Tri-X	www.sapphiretech.com	$350	Hawaii XT	2,816	4GB GDDR5	512-bit	368W	71	9
Gigabyte GTX 970 G1 Gaming	www.gigabyte.com	$350	GM 204	1,664	3.5GB + 512MB GDDR5	256-bit	310W	58	8
XFX R9 290 Black OC Edition	www.xfxforce.com	$306	Hawaii Pro	2,560	4GB GDDR5	512-bit	365W	71	8
HIS R9 280X IceQX2	www.hisdigital.com	$280	Tahiti XT2	2,048	3GB GDDR5	384-bit	351W	69	6
Sapphire R9 285 DualX	www.sapphiretech.com	$250	Tonga Pro	1,792	2GB GDDR5	256-bit	290W	68	7
Asus STRIX GTX 960 OC Edition	www.asus.com	$210	GM 204	1,024	2GB GDDR5	128-bit	247W	58	8
Powercolor R9 280 TurboDuo	www.powercolor.com	$210	Tahiti Pro	1,792	3GB GDDR5	384-bit	308W	67	7
XFX R9 270X Double Dissipation	www.xfxforce.com	$200	Curacao XT	1,280	2GB GDDR5	256-bit	256W	65	5
Zotac GTX 750 Ti	www.zotac.com	$140	GM 104	640	2GB GDDR5	128-bit	160W	62	9

1920x1080 BENCHMARKS (1080p)

	Bioshock Infinite	Battlefield 4	Company of Heroes 2	GRID 2	Shadow of Mordor	Metro: Last Light
Nvidia GeForce GTX 980	**10/116**	**65/103**	**38/55**	**116/147**	**54/87**	**32/53**
Sapphire R9 290X Tri-X	17/107	55/81	27/48	87/115	42/83	25/50
Gigabyte GTX 970 G1 Gaming	17/115	61/92	23/51	104/135	30/77	26/50
XFX R9 290 Black OC Edition	17/101	46/76	32/46	76/105	38/77	8/46
HIS R9 280X IceQX2	17/86	41/64	25/37	70/91	30/60	8/36
Sapphire R9 285 DualX	17/78	34/54	19/33	68/84	16/45	24/33
Asus STRIX GTX 960 OC Edition	19/75	39/58	20/32	70/90	16/36	21/33
Powercolor R9 280 TurboDuo	15/74	36/56	22/31	60/77	26/52	8/31
XFX R9 270X Double Dissipation	16/62	27/46	18/27	46/62	7/19	7/24
Zotac GTX 750 Ti	6/47	26/48	12/24	58/75	14/26	13/27

The initial figures are the minimum frame rate over the benchmark, followed by the average frame rate achieved.
All tests are run at their highest settings with 4x antialiasing where possible. Best scores are bolded.

2560x1600 BENCHMARKS (1600p)

	Heaven 4.0	Bioshock Infinite	Battlefield 4	Company of Heroes 2	GRID 2	Shadow of Mordor	Metro: Last Light
Nvidia GeForce GTX 980	**21/41**	**19/78**	**35/61**	**22/30**	**80/101**	**40/57**	**21/30**
Sapphire R9 290X Tri-X	17/34	16/66	34/53	15/29	66/82	29/60	17/28
Gigabyte GTX 970 G1 Gaming	19/34	21/70	40/55	21/29	71/91	20/49	21/28
XFX R9 290 Black OC Edition	17/32	16/63	29/48	18/27	58/74	27/56	8/26
HIS R9 280X IceQX2	14/25	16/50	22/40	15/22	48/66	21/43	7/21
Sapphire R9 285 DualX	12/21	14/45	20/32	7/12	46/59	13/32	13/18
Asus STRIX GTX 960 OC Edition	11/20	17/43	24/33	1 /17	45/59	11/26	13/18
Powercolor R9 280 TurboDuo	13/22	17/43	20/34	13/18	44/56	19/39	7/18
XFX R9 270X Double Dissipation	10/17	12/34	15/28	0.5/9	33/43	5/14	6/13
Zotac GTX 750 Ti	9/14	9/27	15/27	7/14	31/48	8/15	10/15

The initial figures are the minimum frame rate over the benchmark, followed by the average frame rate achieved.
All tests are run at their highest settings with 4x antialiasing where possible. Best scores are bolded.

3840x2160 BENCHMARKS (4K)

	Heaven 4.0	Bioshock Infinite	Battlefield 4	Company of Heroes 2	GRID 2	Shadow of Mordor	Metro: Last Light
Nvidia GeForce GTX 980	**12/19**	**20/43**	**22/34**	**10/15**	**44/58**	**16/32**	**12/16**
Sapphire R9 290X Tri-X	10/17	16/35	12/32	8/16	44/54	18/36	10/14
Gigabyte GTX 970 G1 Gaming	10/16	17/37	20/29	5/14	38/55	14/28	11/14
XFX R9 290 Black OC Edition	10/16	15/33	17/28	10/15	36/47	17/33	5/13
HIS R9 280X IceQX2	8/13	13/27	13/23	3/5	31/41	10/21	5/11
Sapphire R9 285 DualX	6/10	10/23	7/17	2/5	29/35	6/18	3/9
Asus STRIX GTX 960 OC Edition	5/9	8/21	10/13	3/4	26/34	7/14	5/9
Powercolor R9 280 TurboDuo	7/11	11/23	12/20	4/6	25/35	9/19	4/9
XFX R9 270X Double Dissipation	5/8	7/16	7/13	0.3/1	22/27	4/7	2/7
Zotac GTX 750 Ti	4/7	6/13	8/16	1/5	22/29	8/11	4/8

The initial figures are the minimum frame rate over the benchmark, followed by the average frame rate achieved.
All tests are run at their highest settings with 4x antialiasing where possible. Best scores are bolded.

And the winner is...

Sapphire R9 290X Tri-X

IT'S ACTUALLY QUITE A FRUSTRATING time to be reviewing a whole pile of graphics cards. And that's all AMD's fault. Nvidia has pretty much shot its Maxwell load now, dropping new cards into the high, mid, and low-ends of the market. And now it's topped all that off with the ultra-enthusiast GTX Titan X we've reviewed just a few dozen pages from here.

But AMD is still jealously, or worriedly, holding onto its Pirate Island range of cards. Which means there are no new Radeons in this test. It also explains why prices have been compressed and why there's so little between the cards throughout its current stack. The good news is that the price compression has helped create a couple of diamonds, from a value point of view.

There's a fair amount of detritus, however, so we can quickly discard both the Tahiti-based cards—the R9 280 and R9 280X. They're still remarkably capable gaming cards, and if you've already got a R9 280 sat in your rig right now, then picking up another for just $210 will deliver some quality gaming performance. But they're getting fairly long in the tooth and are lacking the feature set of AMD's later GCN cards, most especially the promising FreeSync tech.

LORDING THE LOW-END

We can also ditch the R9 270X too. There's pricing pressure coming its way from both above and below, courtesy of the R9 285 and the GTX 750 Ti. While the Radeon has higher performance for only a little more money, Zotac's GTX 750 Ti trades benchmark wins with it, while letting you walk away having spent a chunk less cash.

Speaking of the GTX 750 Ti, as we like to do, it's still our favorite budget card, possibly our favorite graphics card ever. At $140 it's a great upgrade for literally any low-end desktop PC, especially if you get one that's entirely bus-powered. It's how you can build yourself a 1080p gaming rig for the same price as a weak-heart console box.

In the midrange there's a bit of a battle royale going on between the R9 285 and the GTX 960. The 285 is sitting at a great price right now and they both deliver similar levels of gaming performance. But the elegant GTX 960 is cooler, quieter, and less power-hungry. Combined with the supporting Nvidia ecosystem, throwing MFAA and GFE into the mix, that just about gives the GeForce card the edge in this one.

At the top of the tech tree things are just as tight. The GTX 970 is a fantastic little card, especially in this Gigabyte version—don't blame the 970 for Nvidia's mess up, it wasn't its fault. But at $350, its performance lead over its closest rival isn't quite enough to justify the extra expense. And that card has a *proper* 4GB frame buffer...

So, it's up to the GTX 980 and R9 290X to fight things out at the very top of this supertest. All things being equal, the Nvidia card is obviously the better option. The impressive GTX 980 is powerful and efficient while third-party 0dB coolers ensure it stays completely silent until it really gets going. But things are not equal. The GTX 980 is currently a full $200 more expensive than the excellent Sapphire R9 290X Tri-X card. The 980's unambiguous performance lead simply can't justify such a huge disparity in price.

Real world result: We'd want the GTX 980 card, but we'd buy the Sapphire.

We've upgraded

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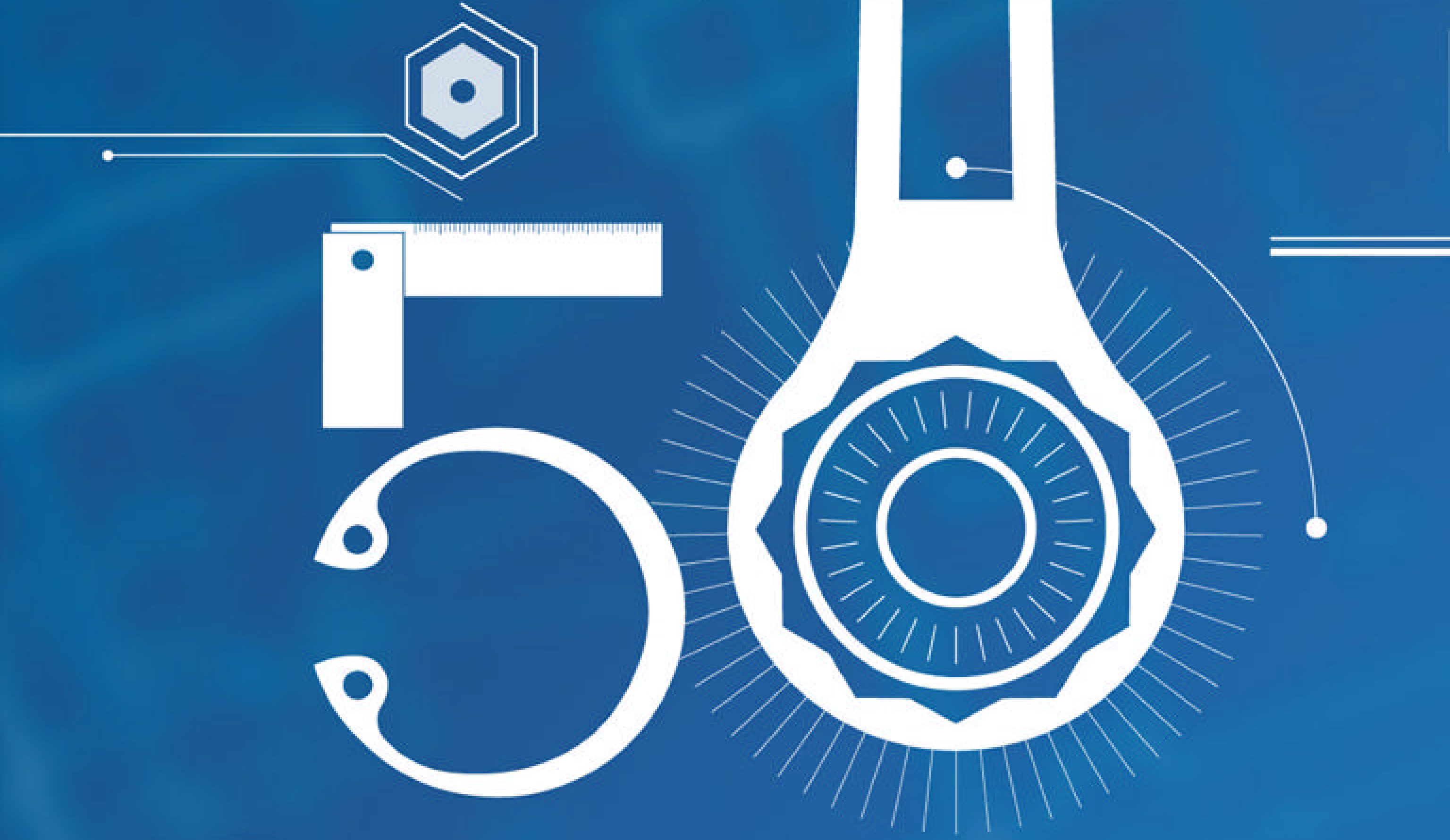

Essential Windows Upgrades

See what Windows 8.1 and Windows 7 can do when it's given your full attention! Ben Andrews and Nick Peers reveal 50 tweaks and apps to upgrade your operating system

Windows 8.1 and 7 are packed with features, many of them honed over years of development, so you could be forgiven for thinking that Microsoft must have covered every base and satisfied every need by now.

The reality is rather different, as anyone who's had to spend extra on an additional antivirus package will appreciate. People tend to forget that essential virus protection, along with programs like Word and Excel, aren't included with Windows, but are actually costly upgrades.

Don't worry though, because the free alternatives out there are just as good. While Internet Explorer and Windows Media Player are both great programs, they're fending off several third-party web browsers and media players that are brimming with innovation. Likewise, Windows' updated Paint app may be streets ahead of previous versions, but it's still no match for a dedicated photo-editing package such as Paint.NET.

Extra programs like these are a tempting way to improve Windows 7 and 8.1, but there are plenty of improvements you can make to the core Windows tools. So, as well as sharing the best free software, we'll show you tricks to fine-tune the tools Windows already has. From calibrating your display settings to produce more accurate colors on your monitor, to reducing unnecessary visual effects to speed up performance, there'll be something for you.

So stop putting up with a disorderly desktop and struggling to find errant files. Here's our guide to the best upgrades, gadgets, and tweaks to help you get the best experience, whatever your version of Windows.

Internet and Security

Try a new web browser

When you're browsing the web, the chances are you'll be using one of the "big three" browsers: Internet Explorer, which comes pre-installed with Windows; Chrome (www.google.co.uk/chrome); or Firefox (www.mozilla.org/firefox). But, if none of these browsers hits the spot, why not give Opera (www.opera.com) a try? It uses the same browser engine as Chrome, which means each tab runs independently, so if a website crashes one tab, it won't bring down your entire browser. But Opera also boasts some unique features of its own: Opera Turbo compresses web pages before they're delivered to your PC to speed up browsing and reduce bandwidth usage, for example. Also, bookmarks are easy to manage—you can even share them with others.

Ensure virus immunity

Windows 7 and 8.1 both offer Windows Defender for protection against malware, but confusingly they're not the same product. Windows 7's iteration offers basic protection against spyware only, while the Windows 8.1 build is a rebadged version of Microsoft Security Essentials. While Security Essentials (windows.microsoft.com/en-US/windows/security-essentials-download) offers some protection, it's still not as good as other free solutions.

The problem with free antivirus and firewall tools is that many bundle other software with them, even previously reputable tools such as AVG and Avast! If you're looking for strong, free antivirus software that won't attempt to sneak anything else onto your system, try BitDefender Free (www.bitdefender.co.uk/solutions/free.html).

Set up a firewall

Windows comes with its own firewall to help protect you from cyber intruders, and the likelihood is your router also comes with a built-in hardware firewall for additional protection. The problem with the Windows Firewall is that it's not —by default—set up to block outgoing connections, so while it protects against attacks originating on the Internet, it won't block malware from "phoning home" to wreak more havoc.

Again, there are plenty of free, third-party firewalls that close this gap, but the same warning applies as with free antivirus software—many now attempt to install extra programs and make changes to your browser settings. One that doesn't is Windows 8 Firewall Control (www.sphinx-soft.com/Vista), which adds extra functionality to the existing Windows Firewall (and works with XP, Vista, and Windows 7, too). Advanced users may like to try Privatefirewall (www.privacyware.com) instead, but be warned, it has a steep learning curve.

Protect from malicious software

A powerful firewall and up-to-date antivirus package are the two cornerstones of a well-protected PC, but your antivirus tool isn't infallible. Therefore, it's best to gain a second opinion—as well as the ability to remove browser hijackers and other PUPs (potentially unwanted programs)—by downloading and installing the free version of Malwarebytes Anti-Malware (www.malwarebytes.org).

It's designed to sit alongside your antivirus tool, but the free version offers no real-time protection, so remind yourself to use it to scan for possible threats at least once a month. It'll let you review its findings, and all suspicious items are quarantined, so you can restore them if it wrongly flags any entries.

Encrypt important files

What if your laptop and documents it contains were to fall prey to a light-fingered layabout? A Windows password may give some intruders the slip, but it's easily foiled.

Microsoft's answer is BitLocker—a brilliant tool that encrypts all the data on your hard drive. Unfortunately, it's only included with the most expensive versions of Windows 7 and 8.1, but there are alternatives. DiskCryptor (diskcryptor.net) is a free app that will protect internal or external hard disks, and even USB flash drives. It's not the easiest software to use

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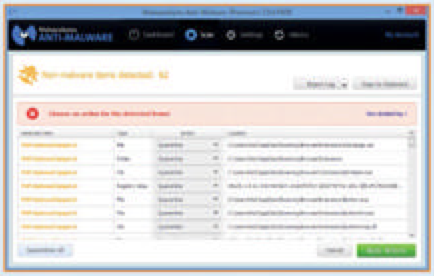
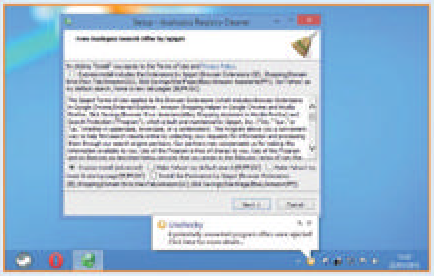


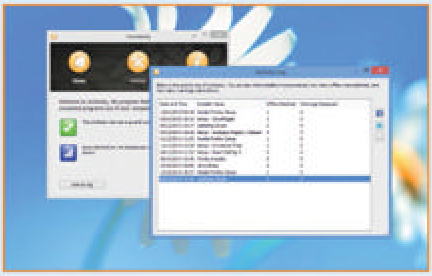
01 Check for existing infections

Run a scan with Malwarebytes Anti-Malware. If any potentially unwanted programs are found, they'll be flagged as PUP. Malwarebytes should remove these. Once done, reboot, and run another scan.



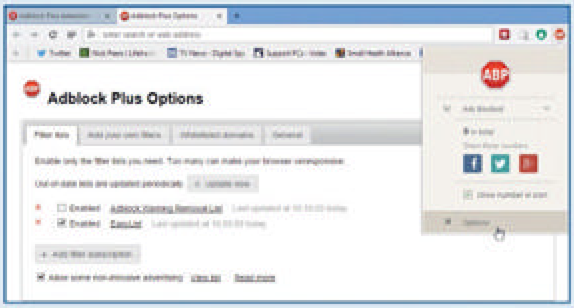
02 Prevent future installations

Now download and install Unchecky (www.unchecky.com). This program will sit in the Taskbar Notification Area, and will alert you—as well as change program options during setup—to prevent PUPs from sneaking onto your PC.



03 Review protection

To see what Unchecky has blocked over an extended period of time, double-click its icon in the Notification Area. Review the summary, or click "Activity log" for a detailed breakdown of which programs were blocked and when.



10 Essential Browser Extensions

Thanks to customizable web browsers, you can make web-surfing even more enjoyable. Extensions make small enhancements, so whether you want to block webpage adverts, download YouTube videos with a click, or increase your browsing security, there'll be an extension for the job. Go to addons.mozilla.org (Firefox), addons.opera.com (Opera) or chrome.google.com/webstore (Chrome) to get these extensions and plugins.

1. Adblock Plus blocks obtrusive ads—including banners, pop-ups, and video ads.

2. LastPass generates and stores passwords for web logins and sensitive information.

3. WOT gets traffic-light safety and privacy ratings for websites and Google search results.

4. TabCloud saves and restores tabs across Chrome and Firefox.

5. Disconnect views and blocks tracking from websites, social media, and more.

6. MyPermissions Cleaner scans key online accounts such as Twitter, Facebook, and more to see which apps have access to them. You can then manage it with just a few clicks.

7. Pocket accesses all the articles, videos, and other online content you saved for later using the Pocket service.

8. Shareaholic quickly shares a link via a wide variety of services, including Facebook, WordPress, LinkedIn, and more.

9. Evernote Web Clipper saves, marks up, and shares content you find online through Evernote.

10. HTTPS Everywhere encrypts your communication with websites wherever possible for a safer browsing experience.

though, so take some time to read through the Wiki on the main page, and take a full system backup before you begin, just in case disaster strikes.

Install specialist email software

Are you still logging onto a web-based email inbox to read your email? A third-party mail client can not only speed up your communication, but will give you plenty of other time-saving features too.

The obvious choice is Mozilla's Thunderbird (www.mozilla.org/en-US/thunderbird), which supports a range of email accounts (including Microsoft, Gmail, and Yahoo!). It's no longer developed, but is updated to squash bugs.

Alternatively, eM Client (www.emclient.com) provides you with an Outlook-style user interface as well as built-in support for calendars and contacts. And if you're juggling multiple email accounts, it's also worth taking a look at Inky (inky.com), which offers a super-minimalist interface that puts the email you want right at your fingertips.

Take remote control of your PC

Wouldn't it be great if you could access your PC remotely from anywhere with an Internet connection? That's exactly what TeamViewer (www.teamviewer.com) lets you do. It allows you to browse your computer from another Windows PC, Mac, or mobile device, wherever you are. You don't even need to leave your PC powered up all day, as most can be woken up remotely from sleep mode.

With a fast Internet connection, this handy app will have you zipping around your files as if you were at your desk.

Share files quickly and easily

What if you want to send a big batch of photos, or even a video? Free image-sharing websites often impose strict upload restrictions, and most videos will simply be too large to send as email attachments.

Uploading to the cloud is the answer. In this sense, the "cloud" just refers to Internet-based storage, and Microsoft's OneDrive (onedrive.com) is one of the most convenient providers. The client's built into Windows 8.1, while those using Windows 7 or earlier can download it from onedrive.live.com/about/en-us/download/.

You get 15GB of free storage, which is more than enough to share a large number of videos or full-resolution photos, and you can always upgrade for more storage. Just log in with your Microsoft username and password at onedrive.com, and you're ready to go.

Make free phone calls

Skype (www.skype.com) is an excellent way to chat with other Skype users for free via your Internet connection. And it's now owned by Microsoft. However, it's not included with Windows, so you'll need to download it from www.skype.com. Then it's just a matter of setting up a Skype account so you can connect to friends and family who use Skype too. You will of course need a PC microphone to be heard, plus an optional webcam if you'd like to be seen too.

Back up files and programs

Backing up your files is the best way to protect them from viruses, as well as hard drive failure. Windows 8.1 comes with File History for file-based backups. Switch it on by pressing Windows–Q, typing "File History" and clicking "File History."

If you'd like to take an exact image-based backup of your PC, you'll find the "System Image Backup" option available here too, but a more flexible tool for taking complete backups is Macrium Reflect Free (www.macrium.com/reflectfree.aspx). It's very easy to use, and not only allows you to back up and restore your entire drive, you can even browse drive images to recover individual files and folders too.

> "Plenty of free anti-virus programs give great protection."

Entertainment and Media

Consider your codecs

Does Windows throw a wobbly when asked to play a DVD or downloaded video? Chances are Windows Media Player isn't to blame. The issue is more likely down to missing codecs. These little files tell Windows how to decode the compression methods used to reduce the size of video files.

Thankfully, Windows can be upgraded with a huge range of codecs to ensure slick playback of even the most modern or obscure video file formats. Just download and install the Combined Community Codec Pack from www.cccp-project.net.

Windows Media Player alternatives

Once you've installed copious codecs, you'd think Windows Media Player would be up for anything, but even with these upgrades, it's still not immune to issues. Windows 8.1 users will note it can no longer play DVD movies, for example. So supplementing it with other video players such as Media Player Classic (www.mpc-hc.org) or VLC (www.videolan.org/vlc) is a wise move.

Both players will handle pretty much any video file format, including DVDs, and, in the case of VLC, some Blu-ray discs too. But it's their extra features that give them the edge. Extensive subtitle, video aspect ratio, and frame rate options are all useful tools, as is VLC's ability to alter audio synchronization so you don't have to put up with inaccurate lip-syncing.

Grow your thumbnails

Even though you can now play most video files, you might find that Windows Explorer still runs into problems when you're browsing through your video collection. It will only generate previews for certain file types, and will turn its nose up at more recent video file formats, such as the MKV standard.

You can broaden Windows' thumbnail-generating horizons using Icaros (www.videohelp.com/tools/Icaros). Simply install the software, open it, and select the video formats that you'd like to generate thumbnails. Once that's done, click the large "Activate Icaros" button and hey presto, extra video thumbnails in Windows Explorer!

Edit your photos for free

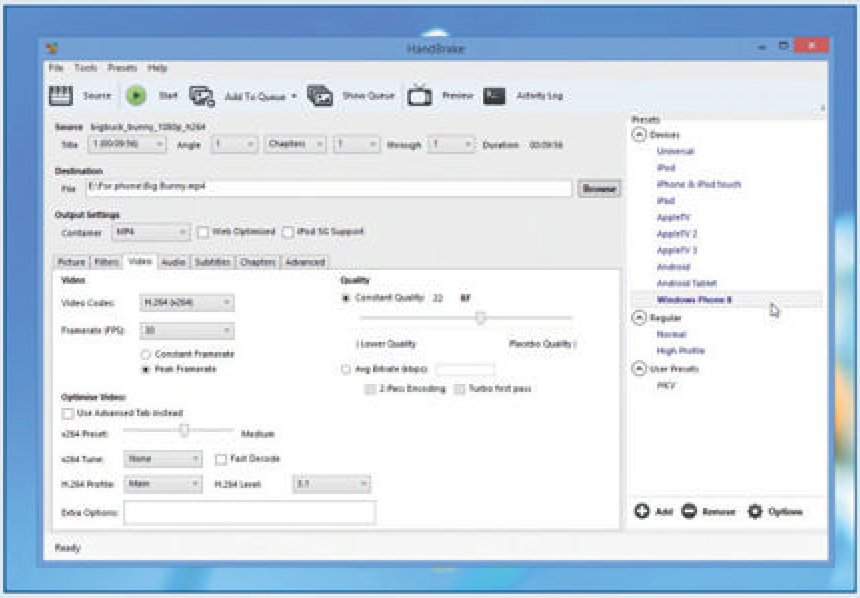
Windows' built-in image-editing tool, Paint, gains small improvements with every release, but even in Windows 8.1 it's still not really fit for purpose, particularly when it comes to editing photos.

Thankfully, there are a whole host of free tools jostling for attention. One of our favorites is Paint.NET (www.getpaint.net), which offers a host of powerful image-editing tools. It also has support for plugins, allowing you to add plenty of extra tools, such as a Shadows and Highlights recovery tool (see http://forums.getpaint.net/index.php?showtopic=5578) or the BoltBait Plugins Pack (www.boltbait.com/pdn/).

View photos in style

It's easy to take Windows Explorer for granted. After all, it's basically the folder windows you use to browse your files and folders. Trouble is, even with customizable thumbnail sizes, it's not really the best way to view things such as photographs.

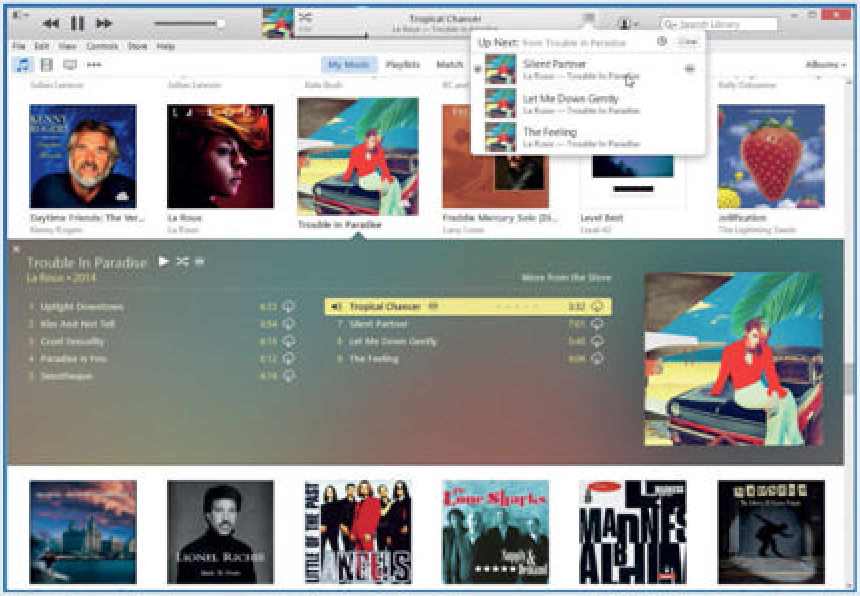
> "Free office suites offer all the features you rely on daily."



Mobile Media

Smartphones and tablets make it easy to watch videos on the go, but many devices will only play a handful of the dozens of video formats out there. Fortunately, HandBrake (http://handbrake.fr) will re-encode most types of video file into a mobile-friendly format, though slower computers could need an hour or two to process a feature film.

If you're planning to watch videos on the move, you should choose the MP4 video format to ensure compatibility with Apple and Android hardware. While you're at it, you might also want to shrink the video frame size of HD footage so it takes up less storage space on your device.



Music To Your Ears

Playing music on your computer is usually no trouble thanks to Windows Media Player, and it'll even help you organize a fairly sizable album collection. However, if your digital jukebox is unwieldy, it can start to struggle.

A popular alternative is Apple's iTunes (www.apple.com/itunes), which will satisfy even the most dedicated audiophile with its comprehensive and attractive music organization, all of which is seamlessly integrated with the iTunes store.

Other free music players to look at include MediaMonkey (www.mediamonkey.com), and don't forget Kodi (see below), which can handle your music library too.

Google's Picasa (http://picasa.google.co.uk) is much more impressive. Its file browser makes it far easier to customize your viewing preferences and organize photos and videos, and there's seamless integration with some clever photo-editing tools. Picasa also includes a dedicated photo viewer, which offers an improvement in speed and usability compared with the version included with Windows.

Take screenshots easily

When it comes to capturing screenshots of your PC desktop, Windows 8.1 introduces new improvements. Hold Windows–PrtScr to save a grab to your "Pictures\Screenshots" folder. The Snipping Tool offers a other options, but it's tricky to use.

Evernote users should take a look at Skitch (www.evernote.com/skitch), which dovetails perfectly with the excellent note-taking app (see below) and functions as a serviceable screen capture tool in its own right.

If you want more flexibility with your screen captures, such as being able to grab specific windows or parts of the screen, save images to a specific folder or edit your image after capturing it. Then PicPick (www.nteworks.com/picpick/) is the tool to go for.

Record, organize, share notes

Got a great idea? Forgotten it a day later? Install Evernote (www.evernote.com) and you'll never have to worry about your crap memory again. This brilliant note-taking tool stores your notes securely in the cloud, so you can access them on the go from your mobile or any Internet-connected computer's web browser.

Notes can consist of text, images, and other file attachments, and can be tagged and organized into notebooks for easy retrieval. Install the web clipper plugin in your browser to capture useful web pages, and even share your notes with friends, family, and colleagues too.

Get productive with improved office apps

Getting a free alternative to Microsoft's Office package is never going to be a bad thing. Windows comes with the WordPad app as standard, which sadly isn't much good if you're used to more comprehensive word-processing software.

If you're a fan of the ribbon-based interface found in Windows 8.1, then Kingsoft Office Free (www.ksosoft.com/product/office-free.html) gives you powerful, free alternatives to Word, Excel, and PowerPoint.

If you need additional tools, including a database and drawing tool, but prefer the old menu-based interface of Office 2003 and earlier, then it's worth checking out LibreOffice (www.libreoffice.org).

Disc-o inferno

Writable CDs and DVDs simply aren't a match for a USB flash drive when it comes to carrying files around with you nowadays, but there are times when you'll need to burn an audio CD, or even a replacement Windows installation DVD. But Windows' own disc-burning tools are rudimentary.

Next time you need to make a disc, give ImgBurn a go (www.imgburn.com). It's a free, uncluttered tool that makes light work of burning all kinds of disc content. Check out the ImgBurn forums for detailed guides explaining how to get the best out of it.

Watch your favorite TV shows on your PC

Once upon a time, Windows Media Center provided the perfect TV-friendly tool for browsing your media (music, photos, or movies) and watching and recording live TV through your PC. Sadly, it's been dropped from Windows 8.1, but there's no need to shed a tear just yet.

Instead, install Kodi (www.kodi.tv), which is a more than adequate replacement. You can alter its appearance to match your personal tastes and extend its functionality with add-ons, such as ESPN. Pair it with Next PVR (www.nextpvr.com) and a USB TV tuner if you want to watch and record live TV through it.

Zip it

When you're downloading files from the Internet, sooner or later you'll come across a compressed file archive, commonly known as a ZIP file. However, there are many ways of compressing files together and compressing them for Internet transfer, and not all forms can be extracted by Windows alone.

To access them you'll need to upgrade to something smarter, such as 7-Zip (www.7-zip.org). This will extract files contained not just in ZIP archives, but also the popular RAR format, plus many other compression formats. Once you've got 7-Zip you'll be able to zip up your own files, often with the output archive being compressed into a smaller space than Windows could manage.

Performance

Make sure you have the latest hardware drivers

Drivers are pieces of software that tell Windows how to communicate with each item of hardware in your computer, but Windows Update doesn't always give you the latest driver versions, so you might need to do it yourself.

You might also struggle to source drivers for older hardware too—often, drivers for older versions of Windows will work fine in Windows 8.1, just make sure you source the right type (32-bit or 64-bit, depending on your current version of Windows). If you're struggling to track down updates or even compatible drivers, employ the services of DriverEasy (www.drivereasy.com). The free version has all the functionality you should need. Choose "Custom" during setup to avoid potentially unwanted programs being installed.

Free up space and resources by removing bloatware

Removing unnecessary software (known as "bloatware" because of the effect it has on your computer) is a great way to free up precious power reserves for an instant performance boost. The "Programs and Features" control panel is the usual port of call for uninstalling programs, but it sometimes leaves a few files behind. Not to worry, though, because Revo Uninstaller Free (www.revouninstaller.com) is a useful app that removes traces of software Windows might miss.

When you're looking through your PC for any programs to uninstall, unused web browser toolbars, expired antivirus trials, and other freebie apps that came pre-installed on your computer should be at the top of your list. Don't worry if you mistakenly uninstall something useful, because Revo automatically creates a System Restore point when it removes an app so you can undo any mistakes.

Unleash ReadyBoost to give your PC more virtual RAM

Lower powered PCs—those with 2GB or less of RAM, and are not powered by a solid-state drive (SSD)—may benefit from this tweak. You'll need a spare USB drive to make it work. The ReadyBoost feature stores frequently used files on the USB flash drive rather than on your PC's hard drive, helping to speed up loading times. Not just any old flash drive will do, though. You'll need a fairly zippy one with a capacity of at least 256MB for ReadyBoost to work.

To see if you've already got something suitably quick for the job, first make sure the drive is blank, then click "Start → Computer" and right-click on the drive's icon. Select "Properties," followed by the "ReadyBoost" tab.

Defrag your drive for more speed

As files are copied, moved, and deleted on your hard drive, they end up scattered about the drive. Defragmentation is the process whereby these files are then tidied up to improve performance and reduce wear on your hard drive. The Windows defrag tool is more than capable of keeping your files in order, but if you'd like more options—such as being able to defrag individual files or folders—then check out Defraggler (www.piriform.com/defraggler).

Note, fragmentation has no effect on SSD performance, and defragging can actually reduce the drive's life, so never defrag your SSD drive.

Tweak the Registry for faster Taskbar previews

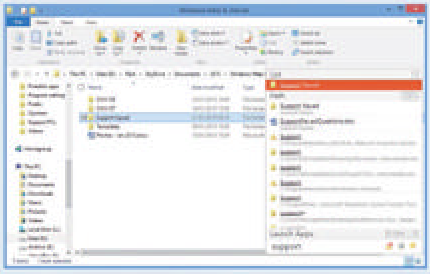
Let's reduce the delay between you hovering over a taskbar icon and a preview window appearing. Click "Start," type "regedit" in the search box and press Enter. Using the folder menu pane on the left, double-click "HKEY_CURRENT_USER," then select "Control Panel" and click "Mouse."

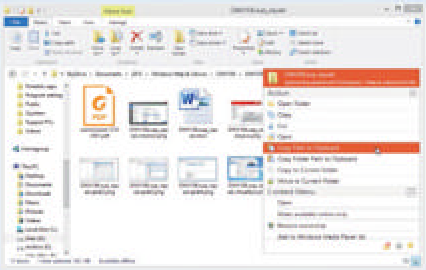
Now find "MouseHoverTime" in the list displayed in the right-hand pane and double click it to reveal a new window. The number 400 in the "Value data" box defines the delay until a preview window pops up, so decreasing this to 100 will speed things up nicely. Click "OK," then restart your computer and things should be snappier.

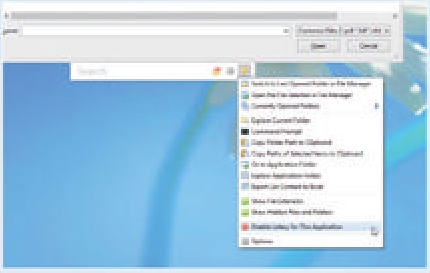
Partition your hard drive to protect your precious data

It's no substitute for storing your data on a separate drive to Windows, but partitioning your drive does add an extra layer of

Step-by-Step Speed up file searches







01 Install Listary Free

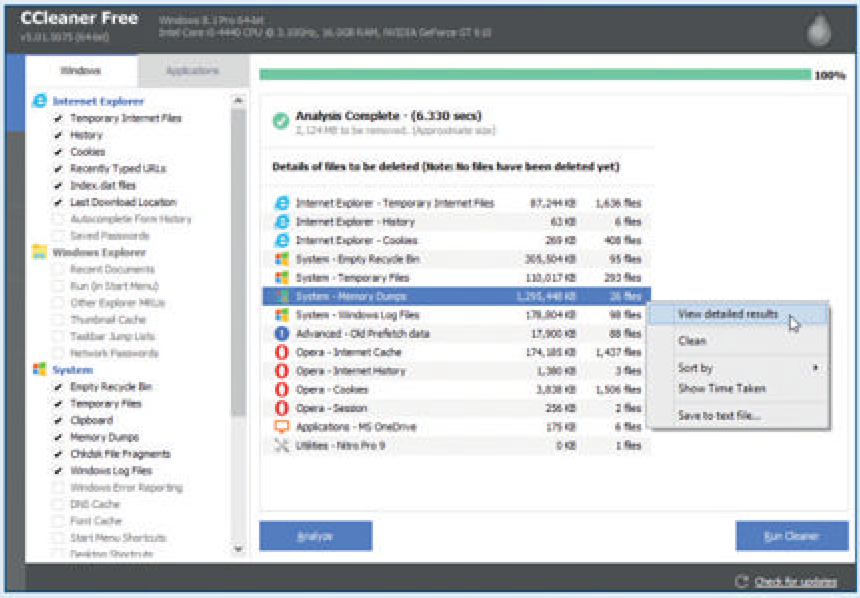
Go to www.listary.com to download and install Listary, a search facility for Windows. Once installed, open a File Explorer window or program Open/Save dialog box and type the name of a file or folder. A list of matches will appear.

02 Work with results

Click a folder to jump to that directory, or click a file to open it. You can also right-click an entry to reveal the Windows context menu as well as additional options, such as copying or moving the item to the current folder.

03 Access more options

You'll see three icons in the search box—the heart folder is a list of Favorite folders, while the stopwatch lets you access recent items. The lightning button reveals more options, such as disabling Listary for the current application.


CCleaner Free
v5.01.5075 (64-bit)
Windows 8.1 Pro 64-bit
Intel Core i5-4440 CPU @ 3.10GHz, 16.0GB RAM, NVIDIA GeForce GT 610
Windows
Applications
Internet Explorer
Temporary Internet Files
History
Cookies
Recently Typed URLs
Index.dat files
Last Download Location
Autocomplete Form History
Saved Passwords
Windows Explorer
Recent Documents
Run (in Start Menu)
Other Explorer MRUs
Thumbnail Cache
Taskbar Jump Lists
Network Passwords
System
Empty Recycle Bin
Temporary Files
Clipboard
Memory Dumps
Chkdsk File Fragments
Windows Log Files
Windows Error Reporting
DNS Cache
Font Cache
Start Menu Shortcuts
Desktop Shortcuts
100%
View detailed results
Clean
Sort by
Show Time Taken
Save to text file...
Analyze
Run Cleaner
Check for updates

Analysis Complete - (6.330 secs)
2,124 MB to be removed. (Approximate size)

Details of files to be deleted (Note: No files have been deleted yet)

Internet Explorer - Temporary Internet Files	87,244 KB	1,636 files
Internet Explorer - History	63 KB	6 files
Internet Explorer - Cookies	269 KB	408 files
System - Empty Recycle Bin	305,504 KB	95 files
System - Temporary Files	110,017 KB	293 files
System - Memory Dumps	1,295,448 KB	26 files
System - Windows Log Files	178,804 KB	98 files
Advanced - Old Prefetch data	17,900 KB	88 files
Opera - Internet Cache	174,185 KB	1,437 files
Opera - Internet History	1,380 KB	3 files
Opera - Cookies	3,838 KB	1,506 files
Opera - Session	256 KB	2 files
Applications - MS OneDrive	175 KB	6 files
Utilities - Nitro Pro 9	0 KB	1 files

CCleaner

Windows' handy built-in Disk Cleanup tool will remove some unnecessary computer clutter, but for a thorough spring clean and to extract even more performance, try upgrading to CCleaner (www.piriform.com/ccleaner).

This free program not only eradicates superfluous, power-sapping Windows files; it'll also tidy up redundant leftovers from any web browser software, Microsoft Office apps, and your antivirus package.

You can choose exactly which types of file you'd like to keep and which ones to sweep, so it's easy to clear your web browser's store of temporary files while retaining any saved website passwords.

protection for your documents and other files. While Windows is capable of constructing a partition, upgrading to a free app such as MiniTool Partition Wizard (www.partitionwizard.com) will make the job easier and give you more options to play with. Just be sure to back up any important files before you start the partitioning process, as messing with the layout of your hard drive does carry a small risk of potential data loss.

Download the all-in-one Windows repair gadget

Fill in the troubleshooting gaps with Windows' built-in repair tools with the essential tweaking.com Windows Repair tool, which can fix both minor and major problems. It could speed up the time it takes getting your PC back into working order by saving you the time and hassle of a full-blown reinstall.

Download and install it from www.tweaking.com. A step-by-step tabbed interface guides you through initial scans and essential backups before proceeding to the "Start Repairs" tab. Review the list of available repairs by clicking on each one for a description, then choose those relevant to your problem before hitting "Start" to set the wheels in motion.

Beat the heat by keeping fans and vents clear

You can upgrade Windows and your other software as much as you like, but it's important to also give your computer's hardware some love and attention. You don't necessarily need to throw money at it in the form of component upgrades either—all you really need is some common sense, and maybe a vacuum cleaner!

Excessive heat can slow a computer down and even damage its sensitive components, so try not to run your laptop nestled in a cushion or comforter where its air intake vents will be blocked. Likewise, it doesn't take long for the fans in a desktop PC to become clogged with dust and gunk, so it's worth vacuuming the dirt from its vents from time to time.

Downgrade appearance to upgrade performance

On the next page you'll discover some clever ways to make Windows look more beautiful. That's all well and good, but older computers won't thank you for slowing them down with additional visual frills. In fact, if your PC is getting on in years, you're better off losing some style to gain some speed.

Press Windows–Q, type "windows performance," and press Enter. Selecting the "Adjust for best performance" option will disable all visual effects to give you the biggest performance boost. Click "Apply." If you come across something that looks a little too crude, like jagged font edges, you can always return to this menu and readjust the offending the option.

Want your PC to perform even better than new?

Disabling speed-sapping features will help boost a sluggish PC, but it may also be possible to give your computer a new lease of life by dabbling in some overclocking. This is a subject we've covered in depth on several occasions, but we know that some readers are still put off by it. Maybe it's time you gave it a whirl?

The good news is that it's now easier than ever to overclock your PC. In fact most modern motherboards offer some form of one-click overclocking for a hassle-free way of finding out if the benefits are worth investigating further. Check out your motherboard's website and manual for more information on how to do get started.

> "Revo Uninstaller removes software Windows might miss."

Customization

Calibrate your monitor for better color reproduction

Calibrating your monitor means adjusting its color output so it's as accurate as possible. You can splash out big bucks on a special device to do the job, but Windows actually includes its own calibration tool. It's well hidden, though.

To find it, press Windows–Q, type "calibrate," and then click "Calibrate display color." Follow the simple wizard to adjust your monitor's brightness and contrast, plus the all-important color balance.

Don't expect dazzling image quality improvements, but if you're a keen photographer and want to view your snaps at their best, calibration is essential.

Ditch the Taskbar for the dock

The Windows Taskbar is perfectly functional, but if you're yearning for something a little more dynamic and attractive on the eye, why not replace it with a dock? Winstep Nexus (www.winstep.net/nexus.asp) is one of the best free ones out there. It floats on top of the desktop, allowing you to place it anywhere on-screen and it works in a similar way to the Taskbar with easy access to your programs, files, and Taskbar Notification area. You can also populate it with plenty of widgets offering extra features such as clock, local weather forecast, and network activity.

Add Windows 8.1 features to earlier versions of Windows

Still running Windows 7 or earlier? Wondering how Windows 8.1 might work, but don't want to upgrade just yet? WinMetro (www.iobit.com/iobit-winmetro.php) transforms your existing Start menu into something similar to the Windows 8.1 Start screen with just a few clicks, for free.

Add News, Weather, Finance, and Photos apps, which display live updates straight to your Start screen, or add search and social media web links. The only thing missing is Windows 8.1's dedicated app store, but that's easily fixed using All My Apps (http://allmyapps.com). Reverting back to the standard Start menu is easy too, so there's no harm in giving this upgrade a try.

Create a desktop slideshow

Windows allows you to replace your single desktop background with a slideshow of photos, but you need to provide the images yourself. Wally (www.becrux.com) is a free tool that allows you to pull images based on keyword searches direct from a variety of web services. Once installed, right-click its Taskbar Notification area icon to get started.

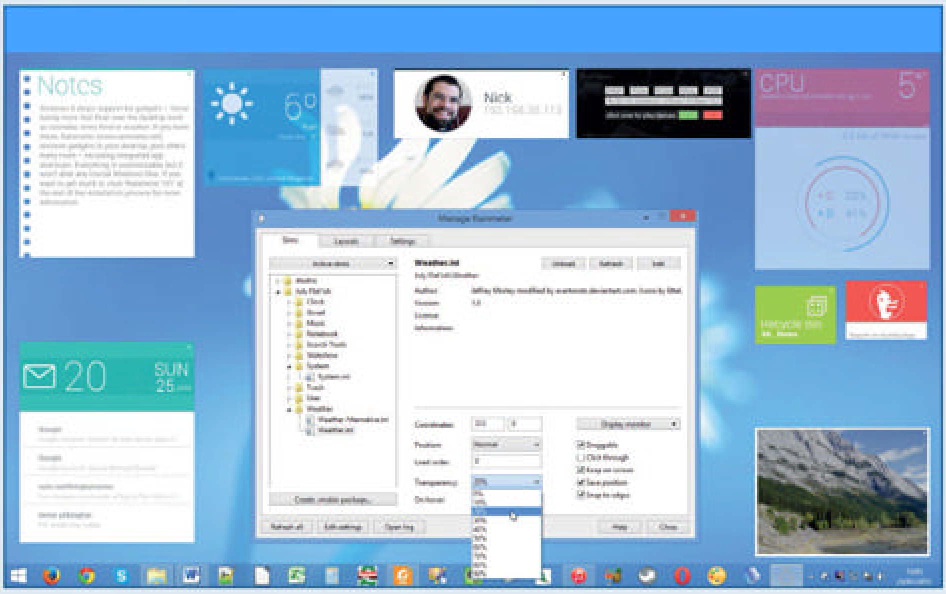
Select one of the online sources, such as Flickr, Yahoo, or Google, then click the "+" button to type in your keywords. Wally changes the background every two minutes—use the "Interval" settings to alter this. Click the "Centered" button to tile or scale your images rather than place them centrally. Finally, just click "OK" to transform your desktop.

Faster filing

Ah, filing. It's a chore in the real world, and not much fun in Windows either. At least MyFolders (www.coretechnologies.com/products/MyFolders) can simplify the process for you.

Install the app, then right-click on a file you'd like to organize and find the menu entry entitled "MyFolders." Click it to reveal "Copy to" and "Move to" options, from where you can specify the folder you'd like to shift the file to. It's also a good idea to accept MyFolders' suggestion to add this folder of choice to its favorites list, making it even easier in future to move the favorite locations of files.

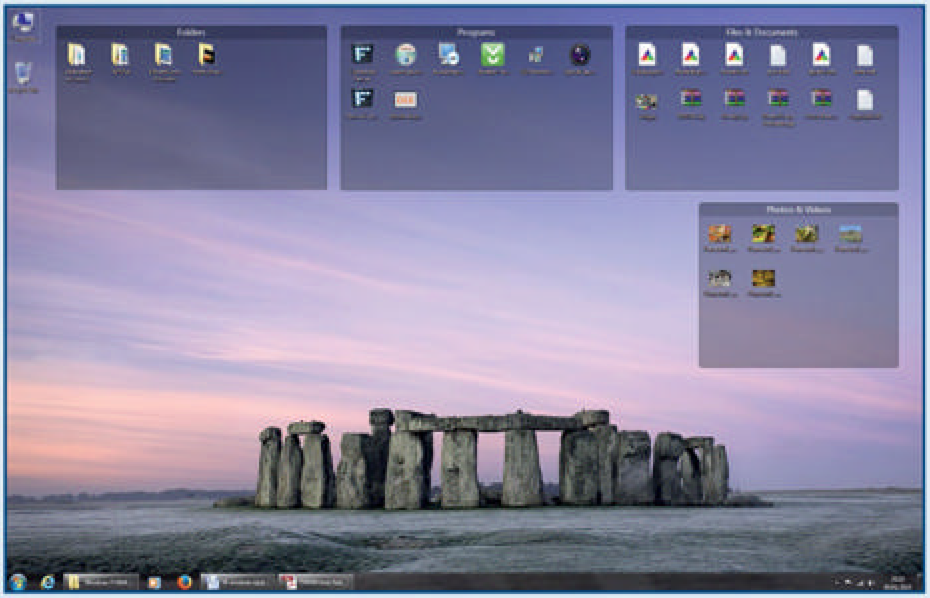
> "Isn't it time we had video backgrounds?"



Make Over Your Desktop

Windows 8.1 dropped support for gadgets—those handy tools that float over the desktop, such as calendar, news feed, or weather. If you want these, Rainmeter (www.rainmeter.net) restores gadgets to your desktop, plus offers many more, including integrated app shortcuts. Everything is customizable, but it won't alter any crucial Windows files. If you want to get stuck in, click "Rainmeter 101" at the end of the installation process for more information.

Desktop Order



Just as your real-life desk can easily descend into chaos, so too can the Windows desktop. We can quickly fill it with program shortcuts and downloaded files, but Windows doesn't offer much in the way of desktop organization.

That's where Nimi Places (http://mynimi.net/Projects/Nimi-Places/) comes in. This free tool allows you to place special containers on your desktop that point to folders elsewhere on your system. These can be moved, resized, and tweaked according to your needs.

Restore the Start menu

Frustrated Windows 8.1 users will be pleased to see that the Start menu is making a very welcome comeback in Windows 10, but you don't need to wait another minute to bring it right back now.

Just download and install the Classic Start portion of Classic Shell (www.classicshell.net), and it'll give you a choice of Start menu ("classic" Windows XP or Windows 7), blended perfectly in with the new Windows 8.1 desktop style. And like all good apps, it's customizable to the nth degree, though in most cases the default settings will be perfect.

Copy files faster

Windows 8.1's file copy dialog is a huge improvement on what went before—the ability to pause and resume file transfers being one obvious advantage. But there's always room for improvement, so if you want to take things to the next level, you need to get your hands on Copy Handler (www.copyhandler.com).

Copy Handler's Advanced features include being able to queue up multiple file transfers, support for restarting file transfers after cancelling them (or even rebooting Windows), and also the promise of faster file transfers, particularly when moving data between two partitions on the same physical hard drive.

You can use it alongside Windows' existing copy tools for occasional use, or use it in place of the native tools.

Build your own Jump List

The Jump List is a great time-saving feature, giving you access to recently opened documents via application shortcuts on the Taskbar and in the Start menu. It's just a shame you can't build your own custom Jump List with all the apps and files you frequently accessed... Except you can, with Jumplist-Launcher (http://en.www.ali.dj/jumplist-launcher/).

Use 7zip to extract JumplistLauncher.exe to a suitable location, then launch the program. Right-click the new Taskbar icon and choose "Pin this program to taskbar," then click it to start adding your choice of file or folder shortcuts (up to a maximum of 60), which can be organized into groups to make them easier to access.

One monitor, multiple desktops

Even with a really well-organized desktop, you could still be struggling for space. Have you ever dreamed of having more than one desktop? Well, Dexpot (www.dexpot.de) turns such a dream into reality by creating up to 20 virtual desktops!

Apart from customizing each one with dedicated wallpaper and the icons of your choice, you can set certain programs to open in a particular desktop. It almost gives the illusion of multiple computers all hooked up to the same monitor, and is a really great tool for separating work and play, so say farewell to procrastination. Well, maybe. All it takes to switch between each desktop is a quick tap of a customizable hotkey.

Ultimate Windows Tweaker

What if you're not a fan of those mini-preview thumbnails that appear whenever you hover over a taskbar icon, or you'd like more control over how IE uses tabs?

Easy, just search www.thewindowsclub.com for Ultimate Windows Tweaker (version 3 for Windows 8.1, version 2.2 for Windows 7/Vista). Download the program and you'll be able to install and tweak settings like these and many more using one simple program. Many of these settings can of course be altered using the standard Windows Control Panel, but finding the right section can often be frustratingly slow. Although most tweaks can be easily disabled, steer clear of altering anything you're not familiar with.

Brush up on the basics

It's easy to overlook Windows's own customization features. One of the most useful is Snap. Drag a window to the side of your screen and it'll expand to fill half the screen. Or drag it to the top to fully maximize the window. On the other hand, if you're swamped with open windows, give the one you'd like to focus on a quick shake by clicking and holding on to its uppermost title bar, and watch as the other windows minimize. Another shake will restore their former glory.

Escape Windows

Don't limit yourself to just Windows. *Nick Peers* reveals the wonders of loading up Linux on your PC

If you've bought a brand new PC with Windows pre-installed and have concluded that Microsoft has finally lost the plot, now is the perfect time to switch to a better OS. Sure, Macs are shiny and expensive, but why go there when you can keep your existing PC and move to Linux? Fear not, gone are the days when Linux meant immersing yourself in command-line chicanery—we'll show you how to install a user-friendly flavor of Linux alongside your existing OS without losing any data, so you can dip your toes into the free and open waters of Linux.

To make the transition as smooth as possible, we've chosen Ubuntu 14.04.02 LTS as our Linux distro of choice. Ubuntu is one of the most user-friendly Linux distros out there, and 14.04.02 LTS is the latest version with Long Term Support, meaning it gets five years of updates and support.

Here's what you're going to do. First, we'd be remiss if we didn't show you how to back up your current PC. You've two basic choices here: the backup tools built into Windows itself, or a tool like SystemRescueCD. Next, we'll explain how modern PCs ship with a new system called the UEFI, which may cause some minor problems. Don't worry, we'll show you how to overcome any issues.

Finally, we'll step you through the installation process itself, which really is a piece of cake. And we won't leave you hanging. Once you've booted into Ubuntu for the first time, we'll take you on a tour of the new desktop, reveal how to access your existing documents and other files, and show you how to get to grips with your new OS. There's never been a better time to make the life-changing switch to Linux, so take our hand and take the plunge.

Back It All Up!

Before migrating to Linux, make a fail-safe backup

The simplest way to back up your system is to use the built-in Windows Backup tool in Windows 7 or later. Just select "System Image Backup" and follow the prompts. It's not exciting and it's a little scary, but it is essential. For a pure Linux backup solution use SystemRescueCD, which you can find at www.sysresccd.org. Here's how…

Once you've downloaded the ISO file and burned it to a disc or USB stick as a CD image, reboot with the disc in your drive, access the boot menu if necessary, usually F11, and choose your DVD drive then SystemRescueCD. Problems could be caused by your PC's UEFI (see p54 on how to fix them). Otherwise, pick the default boot options entry. Type "us" when prompted for the keyboard layout, and type "startx" at the final command prompt.

Once it loads, click the "Menu" button in the bottom left-hand corner and select "System → Show Filesystems" to identify each partition. The Disk entries identify each physical drive (sda, sdb, etc.) and the Device identifies the partitions. In most cases, "sda" will be your Windows drive, so you'll need to back up "sda1" (a small boot partition) and "sda2" (the actual Windows partition). You'll also need to note the partition you intend to back up to and make sure it has enough free space.

Now switch to the Terminal window. To mount the backup partition, type the following command, changing "NTFS" to "FAT" if your backup drive is FAT32, and replacing "sdc2" with the drive's actual partition name:

```
Mount -t ntfs /dev/sdc2 /mnt/backup
```

Reopen the menu and select "System → Partimage." This lets you back up partitions, so start with "/dev/sda1," then press Tab. Next, type "/mnt/backup/sda1-backup.gz" into the "Image file to create/use" box. Leave "Save partition into a new image file" selected and hit F5. Check "Gzip" is selected under Compression level, then press F5 again. Enter a description if you wish, then hit Tab to select the "OK" button and hit Enter. Make a note about experimental NTFS support, then click "OK" twice, also noting the drive statistics. If this completes, repeat to back up your Windows partition, naming it "sda2-backup.gz" instead.

To back up your computer's Master Boot Record, open a Terminal window and type the following commands

```
cd mnt/backup
mkdir partition-backup
cd partition-backup
dd if=/dev/sda of=backup-sda.mbr count=1 bs=512
```

to back up MBR. Now back up your partition table with:

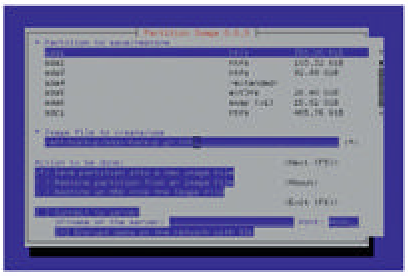
```
sfdisk -d /dev/sda > backup-sda.sf
```

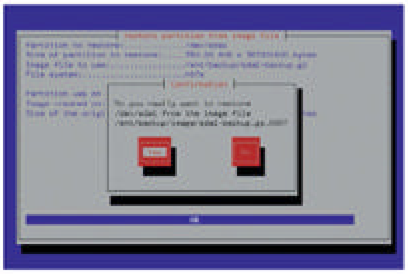
If you get a warning about sfdisk not supporting GPT partitions, type "sgdisk --backup=backup-sda.sg /dev/sda" instead. If disaster strikes, either boot from your Windows rescue disc, or boot back into SystemRescueCD. If you got as far as Ubuntu resizing your Windows partitions, you'll first need to launch the "Gparted" partitioning tool from its Taskbar shortcut. It should display your main hard drive (/dev/sda), so identify the extended partition. Right-click each volume inside it and choose "Delete," then right-click the extended partition and delete that too. Next, right-click your Windows partition and choose "Resize/Move." Allocate it all available space and click "Resize/Move" followed by "Apply." To complete the partition restore process, follow the three-step guide below. The final step is restoring your MBR. Open another Terminal window and type:

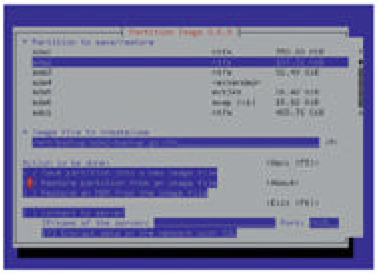
```
cd /mnt/backup/partition-backup
dd if=backup-sda.mbr of=/dev/sda
```

If you backed up your partition using sfdisk, type "sfdisk /dev/sda ← backup-sda.sf" into the command prompt. If you used sgdisk, type "sgdisk --load-backup=backup-sda.sg /dev/sda" instead to complete the restore.

Restore Your Original Setup







1 Select backup

Boot into SystemRescueCD and follow the steps in the main text (above), up to identifying your partitions. Next, mount the backup partition in the "/mnt/backup" directory. Once done, open "PartImage." Leave "sda1" selected, type the backup path and name from before into the "Image" file box.

2 Restore boot partition

Press Tab twice to highlight the asterisk next to "Save" partition, then press the Down Arrow followed by Spacebar to select "Restore" partition from an image file. Press F5. Note the description and press Enter again. Press F5 to restore the partition, working through the warnings until the files are copied back.

3 Restore main partition

PartImage will close once the partition has been restored so launch it again, but now select your main "Windows" partition (typically sda2). Then it's a case of repeating the previous steps, only this time using the first backup file. Note the restoration relies on your Windows partition being the same size.

Handling UEFI & Ubuntu

Get your system configured correctly, even Windows 8 systems

Modern PCs, particularly those with Windows 8 pre-installed, have replaced the traditional BIOS with a new system called UEFI. Both perform the same job, detecting and initializing your hardware before handing it over to your OS, but UEFI represents a quantum leap forward from the somewhat primitive capabilities of the traditional BIOS. The UEFI offers a much wider range of features than that found in the BIOS, all wrapped up in a much more user-friendly, graphically pleasing interface.

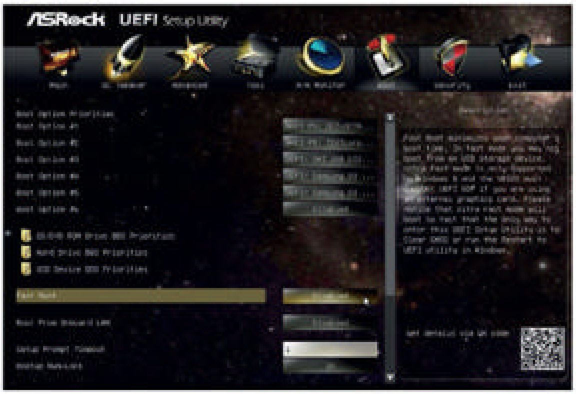
There are, however, potential issues to circumvent. First, because UEFI is a newer standard, it's not compatible with legacy hardware. This problem is circumvented by a special Compatibility Support Module (CSM), which enables you to emulate the BIOS to run older hardware and OSes.

More controversially, UEFIs also ship with a Secure Boot mode, which, while making PCs less susceptible to malware, can lock the PC to only using Windows 8. Again, this feature can—in most cases—be disabled, but the good news is that Ubuntu 14.04 LTS fully supports newer hardware and Secure Boot, so you won't need to disable either to install it alongside Windows. One UEFI feature you'll definitely need to disable, however, is FastBoot (also called QuickBoot or FastStartup).

Tweak the UEFI

Accessing the UEFI is the same as entering the BIOS setup utility. Simply switch on your PC, then tap the key prompted to enter setup when it appears on-screen, typically F2 or Del. First, verify that FastBoot has been disabled by looking for a section called "Windows 8 Configuration," or—if that's not present—"Boot." Once you've found it, make sure it's switched off or disabled.

You may need to tweak the CSM and Secure Boot settings if you intend backing up your system using SystemRescueCD. Again, look in the Windows 8 Configuration if it exists for Secure Boot, which may be listed as "Windows 8 Logo Requirement." Either way, disable it should you have problems booting SystemRescueCD. If the section isn't present, look under "Security" instead.



Make sure your FastBoot settings are disabled before attempting to install Ubuntu.

The CSM module may be part of the Windows 8 Logo Requirement screen, or it'll be hidden away on its own (we found it buried away at the bottom of the Boot menu on our ASRock motherboard, for instance). Click this to reveal a selection of different options covering different hardware. Look for references to PXE (pre-boot environment), GOP (graphics), and Storage (or SATA), as well as USB and PS2, if applicable. This enables you to selectively switch CSM on and off for specific devices as required.

Some motherboards—including our ASRock—enable you to run both modes as required. (In the case of ASRock, we set each one to "Do not launch" to make this setting the norm). If there are no apparent options for editing the Secure Boot or CSM settings, contact your PC manufacturer to verify whether or not these can be disabled. In most cases, PCs built using off-the-shelf motherboards should have the required options available, but some manufacturers have been known to provide hobbled boards.

As we mentioned earlier, upgrading a PC's graphics card often requires enabling CSM support. So, even if the controls aren't already supported, the manufacturer may have relented under pressure from end users and provided a UEFI update on its website to enable the required options—Advent's DT2410 PC is an example where this happened.

Choose The Right Boot Option

Many modern PCs now give you the option of booting in UEFI or legacy BIOS mode, with the latter allowing you to install older operating systems. Ubuntu works fine with both UEFI and Legacy modes, but other environments—such as SystemRescueCD—require booting from a legacy option.

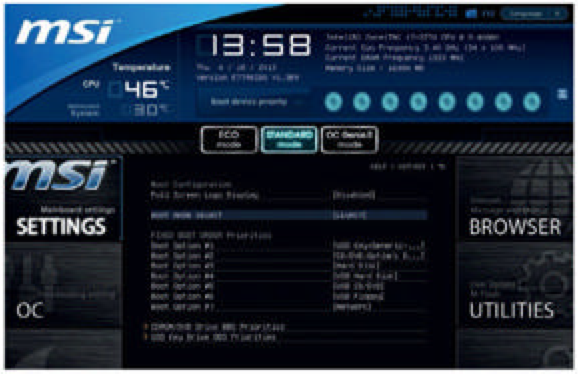
Some PCs even support mixed-mode booting, presenting both legacy and UEFI choices direct from the boot menu, so you don't need to wade into the UEFI shell to switch between them. If you've wondered why some boot options have been displayed twice, this is why: look closely and you'll see one option is prefixed by UEFI. This gives you the option of choosing which mode to boot that drive in.

It's a good way of testing whether a certain OS or bootable disc works with UEFI or not. If you're only offered a single set of boot options, your UEFI shell will only allow you to boot in either UEFI mode or legacy. The latter requires CSM to be enabled, but once done you should be able to change boot settings—including device priority—from within the Boot section of the UEFI shell.

If your PC supports mixed-mode booting, you may need to set a different default boot device, in which case take care to select the right mode when choosing which device (typically optical or boot hard drive) to make the default.

With your Windows system backed up and the UEFI configured correctly, it's time to press on and install Ubuntu alongside your existing setup. One of the reasons we've chosen Ubuntu is that its user-friendliness is apparent from the moment you install it. The setup process is painless and relatively straightforward to follow. Simply head on over to www.ubuntu.com/download where it is free to download, then follow the instructions to get going.

Wait for a few minutes and after a short pause where the screen goes gray and then red, the Welcome screen will appear. You'll be given the option of either trying Ubuntu or installing it—select the "Install" option. Next, tick both boxes: "Download updates while installing" and "Install this third-party software." Click "Continue," then wait while the updates are downloaded in the background.



Check your UEFI shell's Boot settings to see whether Legacy, UEFI, or mixed mode are selected.

Install Ubuntu 14.04.02 LTS

The "Installation Type" screen should then appear. In most cases it should seamlessly detect your Windows installation—leave "Install Ubuntu" alongside... and click "Continue."

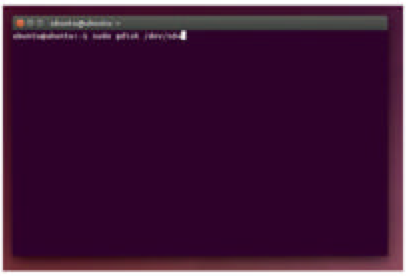
If Windows isn't offered as an option, this means Ubuntu hasn't detected it. If you're running a newer PC with a UEFI installed in place of the traditional BIOS, you'll need to make sure you boot from the optical disc using the same option that Windows was installed with. Reboot your PC, then choose the alternative optical disc option from the boot menu to see if Ubuntu now detects your Windows installation. If the option doesn't appear whether you choose UEFI or the legacy option, then it could be down to your partition table containing both MBR and GPT records (see below for the step-by-step guide for a way to resolve this issue).

The next screen sees Ubuntu automatically find some free space for itself—either by carving up your current Windows partition, or by locating more space on another attached drive and repartitioning that instead. If you don't want it installing on a USB drive, then power down your PC, disconnect the offending drive, and then start again. Ubuntu needs a minimum of 6.4GB free space, but will take up to 40GB if it can. You can alter this figure by clicking and dragging the gray space between both suggested partitions. It's smart enough to not allow you to swallow up your entire Windows partition, but if you plan to continue using it going forward, try to leave at least 10GB free space if you can, and preferably more. In most cases, the default choice should be fine, anyway, so click "Install Now." Note the comment about partition resizing, and click "Continue."

You'll next be prompted to choose your geographical region—the installer should automatically detect this—then click "Continue" to select your keyboard layout. In most cases, the default US keyboard layout is the one to pick, so click "Continue" again. You'll now be prompted to enter your name. As you enter it, Ubuntu will populate both the computer's name and username fields based on your choice—you're free to edit both should you choose. The final choice available to you is to pick a password. Select one that you'll easily remember, as you'll need this not just to log into Ubuntu but also to perform administrator-level tasks.

Click "Continue" again, and you can sit back and wait for Ubuntu to install itself on your PC—it really is that simple. It's worth hanging around as the installer will reveal some useful pointers for your first steps into using Ubuntu. But turn the page and we'll take you on your own personal tour of your shiny, new desktop and operating system.

Fix Windows Detection Issues

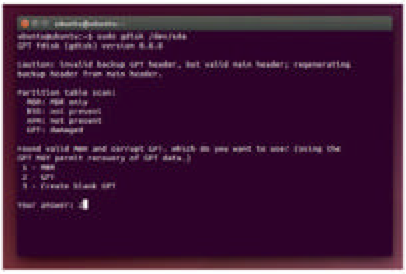


```
ubuntu@ubuntu:~$ sudo gdisk /dev/sda
```

1 Launch Ubuntu Live

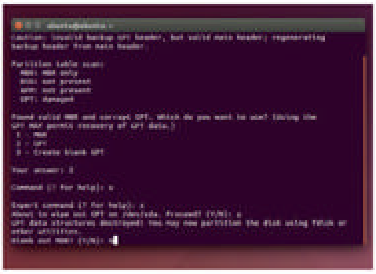
If your Windows install isn't detected, click "Back" until you return to the Welcome screen. Click "Try Ubuntu" to load the live CD. When it's loaded, press Ctrl-Alt-T to open a Terminal window. Then type the following command and hit the Enter key:

```
sudo gdisk dev/sda
```



2 Verify and fix

If gdisk says it has found both an MBR and a GPT, then the presence of GPT is the problem. Removing it will enable Ubuntu to see your Windows partition. First, select the GPT entry by typing "2" and hitting Enter. Then, when prompted, type "x" and hit Enter to access Expert command mode.



3 Apply and reboot

Type "z" and hit Enter. When prompted to wipe the GPT on "/dev/sda" type "y" and hit Enter. When asked if you'd like to blank the MBR, make sure you press "n" and hit Enter and close the Terminal, then reboot and try to install Ubuntu again. This time you'll see the option to install it alongside Windows.

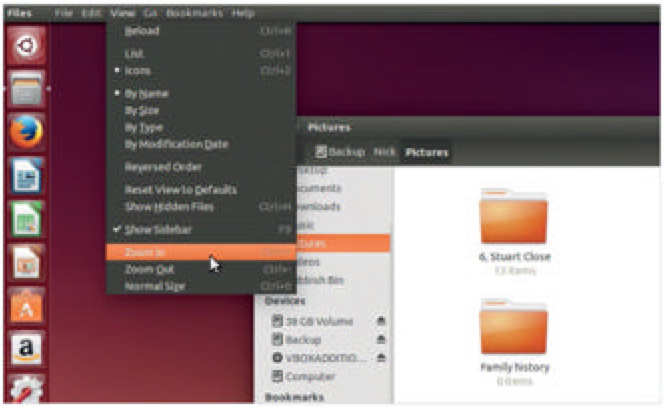
Get Started with Ubuntu

Take your first steps into the Unity desktop

You've installed Ubuntu and rebooted your PC. The first change you'll see on startup is the presence of a new boot menu called GNU Grub (see "All About Grub", p59). This enables you to choose which OS to boot into, plus gives you access to a memory testing utility. The default choice is Ubuntu, but before booting into it for the first time, we recommend selecting the "Windows" entry. This lets Windows boot for the first time since the Ubuntu installer resized your partitions—you'll note it immediately runs the disk-checking tool to verify and update its own partition records. Let it do this, then once complete it'll restart your PC. Select "Windows" again from the Grub boot menu to check all is well. Assuming it is, restart your PC again.

This time, leave "Ubuntu" selected and hit Enter to boot into your new OS for the first time. After the loading screen flashes by, you'll be prompted to enter the password you set up during installation. Type this in, hit Enter, and you'll arrive at Ubuntu's desktop, which is called Unity.

The Unity desktop shares some similarities with Windows, such as the presence of shortcut icons on the left, but you'll also notice some key differences, which will feel more familiar to those who have used a Mac. First, the Menu Bar at the top of the screen works in a similar way to Windows' Taskbar Notification area, with a number of icons providing access to key tools. From the off you'll see—from left to right—network, keyboard, volume, date/time, and settings. Most of these are self-explanatory—click one to reveal its Options menu.



The main distinction for former Windows users trying out the Unity desktop environment for the first time will be the position of the launch bar.

The Settings button is the most interesting of these. Not only does it provide access to the power options, it enables the ability to quickly switch users, log out, or lock the computer, and it also provides a handy shortcut to Ubuntu's System Settings, more of which in a moment.

When you open an app, its title will also appear in the Menu Bar. Roll your mouse over the Menu Bar and its menu items will appear. Clicking one will open its menu.

The App Launcher

The shortcut icons displayed on the left-hand side of the screen are part of Unity's App Launcher. Rather than cluttering up your desktop with icons, these are all housed in a single column—simply roll your mouse to the bottom or top of the launcher to reveal more shortcuts. The App Launcher houses shortcuts to applications, workspaces, removable drives, and the Rubbish Bin, but the two shortcuts at the top are of particular interest. The top one lets you quickly search your computer and the Internet from one handy window, while the Files shortcut gives you access to a file manager, making it easy to browse, access, and manage your files. Again, more on that later.

To find out more about a shortcut, simply roll your mouse over it and its title will pop up. Click one to open it. As time moves on, you'll want to know how to add and remove shortcuts from the App Launcher—to remove a shortcut, simply right-click it and choose "Unlock from Launcher." The simplest way to add a shortcut is to use the search tool to locate the app in question, then simply click and drag its shortcut into place on the Launcher. You can also reorder items in the Launcher by simply clicking and dragging them to their new spot.

The desktop itself works in a similar way to Windows, and can be used to house files, folders, and shortcuts should you wish to clutter it up. Again, it uses the familiar right-click menu to provide you with options for creating folders, managing existing icons, and changing the desktop background should you wish.

Ubuntu can detect both FAT32 and NTFS partitions, so accessing your old data shouldn't be too much of an issue.

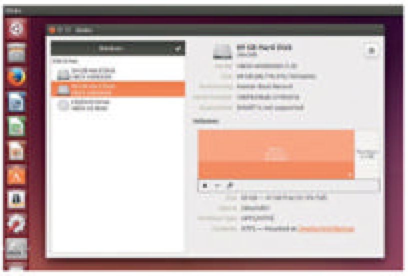
Get More Apps

Ubuntu 14.04 LTS ships with a few apps pre-installed, notably LibreOffice and the Firefox web browser. For a complete list of installed apps, open the Ubuntu Software Center and select the "Installed" button. Expand a category to see what apps there are, such as Rhythmbox. Use the Search box to locate them, then either open them directly from here or drag a shortcut on to the App Launcher. There are many more apps you can add to your Ubuntu installation, and the vast majority are free. There are a number of ways to do this. As you've seen with Ubuntu Tweak, (see "Accessing Your Documents", p57) you can download apps directly from the web. If they're packaged as Deb files, you can double-click them and have the Ubuntu Software Center manage the installation.

You can also search for more apps from within the Software Center too—just use the Search box. The Ubuntu Software Center isn't a definitive source for apps, however. Linux apps are housed in special collections called "repositories," and as you'll see over the page, you can install apps via the Terminal too.

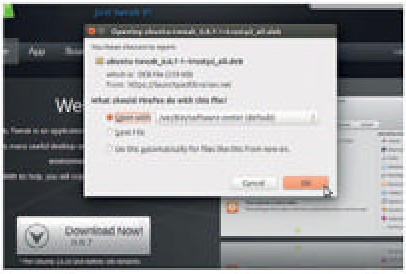
One thing you'll want to do is access apps for specific file types, such as images. If you can't find an app, try double-clicking a file you want to open—if you get a "Could not display" error, click "Yes" to search the Ubuntu repos for apps.

Accessing Your Documents



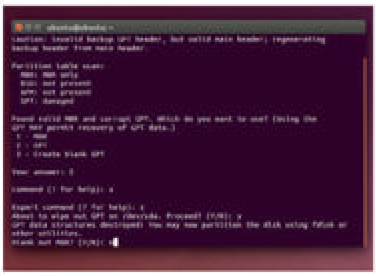
1 Identify mount point

Click the "Search" button in the App Launcher, type "disks" and click the "Disks" shortcut under Applications. Assuming you've moved your data to a new drive, select this drive in the left-hand pane. Now highlight the partition that your data is stored on under Volumes and make a note of where it's mounted.



2 Install Ubuntu Tweak

Open the Firefox web browser and head to http://ubuntu-tweak.com. Ignore the Launchpad prompt, then click the latest "Deb Package" link (which is 0.8.7 at time of writing). Next click "OK" to launch it with Ubuntu Software Center, then review the package description before clicking the "Install" button.



3 Move user folders

Click the "Search" button, type "Ubuntu" and select "Ubuntu Tweak" under Applications. Select "Admins → User Folder." Each folder will be listed. Select one and click "Change." Browse your data partition for the corresponding folder, select it and click "Open." Repeat for all the other user folders.

You should see these drives appear in the App Launcher—clicking one will open its contents for viewing. If you're looking for your personal data, then unless you've specifically moved the folders in Windows, you should find all your documents in the Users folder under your username.

Access your data

You can also access the graphical Nautilus file manager by simply clicking the "Files" shortcut on the Launcher. It provides a familiar two-paned window, with a series of shortcuts on the left and the contents of the currently selected folder or drive on the right. By default, items are displayed in a grid, but you can switch to list view using the buttons in the top right. You'll also see a "Search" button, which enables you to search the currently selected folder (and sub-folders).

If you want to copy data from your Windows partition to your user folders in Ubuntu, browse to one of your user folders—Documents, for example—then click and drag all of its contents on the "Documents" shortcut in the left-hand pane. It pays to make sure you have enough free drive space. If you plan to continue using Windows alongside Ubuntu, a better solution is to set up a spare drive or partition as a dedicated data drive, allowing both Ubuntu and Windows to access the same copy. This needs to be a FAT32 or NTFS partition so Windows can access it as well as Ubuntu.

> "Ubuntu can detect both FAT32 and NTFS, so accessing your old data shouldn't be an issue."

Assuming such a partition is in place, set it up by first booting back into Windows. Now create dedicated folders for Documents, Pictures, Music, and Videos on your data partition. Next, open your Windows User folder, right-click your "Documents" folder, and choose "Properties → Location." Click "Move" and select the "Documents" folder on your data partition. Click "OK" and then enable it to move all your existing data across to the data partition. Repeat for your other folders.

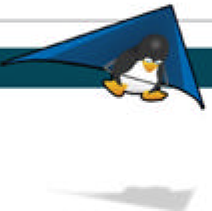
Once done, boot back into Ubuntu. Your files should now be easily accessible from the data partition, enabling you to make changes to them using both Windows and Ubuntu programs. To make the change complete, follow the step-by-step guide to point your Ubuntu user folders to the same location. We recommend following the advice given and leaving the Ubuntu desktop folder alone. Once done, test the tweaks work by opening Nautilus and clicking the "Documents" shortcut in the left-hand pane, which should now point to your data partition.

To access your network, open a folder window and you'll see network options on the left of the screen. Click "Browse Network" to find other computers—there's a handy "Windows Network" shortcut for accessing Windows PCs. Alternatively, if you know the computer name, click "Connect to server" and type "smb://comp-name" and click "Connect." Have your username and password ready if necessary.

Ubuntu should automatically handle all of your PC's hardware, using generic drivers if necessary, but you can review what's been installed, plus look for additional drivers (specifically for gaming, Wi-Fi, or printing) using the Software & Updates app. Open a Search box, type "Software" and then click the "Additional Drivers" shortcut. It will search for any driver updates that may exist and alert you to any alternative or proprietary drivers you may have installed.

If you store data in the cloud, the good news is that Ubuntu supports a wide range of cloud providers, which is fortunate, seeing as it recently dropped its own Ubuntu One cloud storage service. Some providers are officially supported on Linux, such as Dropbox (www.dropbox.com/install).

If you're looking for stacks of free storage then Google Drive offers 15GB, making it a good option, but as yet there's no official Ubuntu support. A number of third-party offerings exist, and if you're prepared to pay $15, InSync (http://insynchq.com) is the tool of choice. You could, of course, use OwnCloud to set up your own storage.



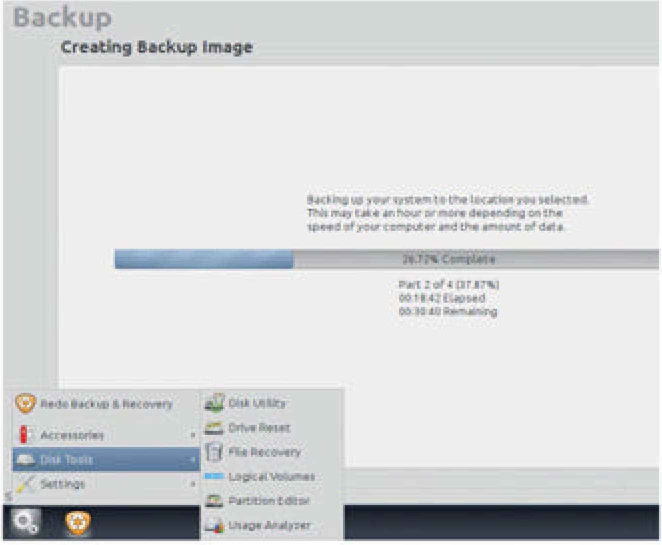
The Vitals of Linux

Discover the key tools and techniques you'll need to know

Now you've familiarized yourself a little with the Unity desktop, it's time to plunge deeper into the Linux ocean and arm yourself with more of the important knowledge you'll need to use it going forward. Before diving in, however, it's a good idea to take a system backup—as you start to learn Ubuntu you may make mistakes that could lock you out of your system. (See "Take Another Backup," below).

First, let's take a look at the Linux file system and how it's organized into folders. First, Linux uses a different file system to Windows (NTFS or FAT32). It's called "ext4." This makes your Linux folders invisible to Windows, which can't natively read ext-based drives. That's fine—we've moved your data on to a shared partition that both OSes can see, and it's better that you can't accidentally access your Ubuntu partitions.

Now, open Nautilus where you'll be taken to your Home folder. This works in a similar way to your Windows user folder, and normally contains all of your personal files, though we've moved key folders across to your data partition so you can share files with your Windows installation. Shortcuts to these key folders can be found in the left-hand pane. Now click the "Computer" link under "Devices" and you'll get a look at a load of other folders too. Most of these can be safely ignored on a day-to-day basis—the "bin" folder is where your programs are stored, for example—but two worth noting are "media" and "mnt." These are where shortcuts to any external drives and network folders you've connected to can be found.



Backing up your system to the location you selected. This may take an hour or more depending on the speed of your computer and the amount of data.

26.72% Complete

Part 2 of 4 (37.87%)
00:18:42 Elapsed
00:30:40 Remaining

Take a backup of your dual-boot system using Redo for extra security.

The key difference between the two folders is that drives mounted in the "/media" folder are mounted on a per-user basis, and don't require elevated access before they are mounted. This means they're not available to the system before you log into your account, which can cause some issues with start-up programs. See http://bit.ly/MountWinParts for more information—jump to the Configuring "/etc/fstab" section for a guide to mounting partitions before login occurs to circumvent this problem.

Key system tools

While Ubuntu requires you to access the command line for some complicated tasks, there's a lot you can do without it. We've already introduced the Disks utility in the "Accessing Your Documents" guide on p57. Disks lets you manage your drives and their partitions—by selecting one, clicking the "Settings" button, and choosing "Edit Mount Options," you can make changes to the way partitions are mounted without having to edit the "fstab" file directly. But use with care. If drives don't behave as you expect, flick the "Automatic Mount Options" switch back to "On" to restore the status quo.

Many system preferences can be accessed via the System Settings tool—click the "Settings" button on the Menu Bar to access it. You'll see three section buttons: Personal, Hardware, and System. From there you can access a particular preferences tool. Select "Appearances," for example, to tweak some desktop settings, such as hiding the App Launcher when not required and moving an application's menus to its own window.

You can also install a tweaking tool. We've already seen how the Ubuntu Tweak Tool can be used to move your home folders (p57). It also includes a handy Apps tab that makes it easy to install new software. Also take the time to explore the Tweaks section and, in particular, the Unity component where you can do things such as resize the Launcher icons.

Take Another Backup

Now that Ubuntu is safely installed on your PC, it's time to consider taking a fresh backup of your hard drive. You can, of course, use SystemRescueCD for this purpose. If all this sounds like too much hassle, then you could try Redo Backup and Recovery instead. Download the ISO file from Sourceforge (http://bit.ly/Redobackup) and burn it to disc. In Ubuntu, insert a blank CD and click "Cancel" when the "Choose application to launch" window appears. Now locate the ISO file (typically in your Downloads folder), right-click it, and choose "Write to Disc," then click "Burn."

When the disc has been created, reboot and choose to boot from the disc—you may need to tweak your UEFI settings; enabling CSM for storage should be sufficient. Select "Start Redo Backup" (choose the "Safe Mode" option if this doesn't work) and click "Backup" when the main screen appears. Select your drive, then choose which partitions to back up. Then it's a case of selecting your backup drive and creating a folder into which your backup will be stored. Give your backup a name and then "Redo Backup" the rest.

Should the worst happen, recovery is as simple as clicking "Restore" instead of "Backup" and following the prompts. You'll also find a settings button in the bottom left-hand corner where a number of useful disk-related tools reside.

All About Grub

When you install Ubuntu alongside Windows, it adds a special boot loader to your system that provides a boot menu for choosing between Ubuntu and Windows on startup. That boot loader is called Grub 2. It's designed to wait a short period of time before automatically loading Ubuntu. You can configure how Grub behaves—choose a shorter or longer time before it starts loading the default choice, and even change that choice, by editing its configuration file and updating Grub via the Terminal. Before doing so, make sure you've backed up the system.

Once done, open the Terminal, then type "sudo apt-get install gksu" followed by "gksu edit/etc/default/grub &." This opens the Grub configuration file in a Gedit window. From here, you need to edit the existing file with whatever changes you wish to implement.

First, the "GRUB_DEFAULT=0" line is what makes Ubuntu the default choice at boot time. To make Windows the default choice, and assuming there are five entries in the boot menu (Ubuntu, Ubuntu advanced options, two memory test options, and finally Windows), change this to "GRUB_DEFAULT=4." Alternatively, to switch default OS to whichever one was selected previously, change "GRUB_DEFAULT=0" to "GRUB_DEFAULT=saved," then add a new line immediately below this: "GRUB_SAVEDEFAULT=true."

You can also change the length of time—in seconds—that Grub waits before it boots the default choice. Simply change "GRUB_TIMEOUT=10" accordingly.

When you've done this, click the "Save" button and close the Gedit window. Ignore the warning and type "sudo update-grub" to update the boot loader.

Two other tweaking tools worth exploring are the Unity Tweak Tool, which gives you even more fine control over the desktop, and Tweak Tool. Both can be found via the Ubuntu Software Center—choose the trusty-backports version of the Unity Tweak Tool. Both offer similar point-and-click access to hidden system settings.

Repositories

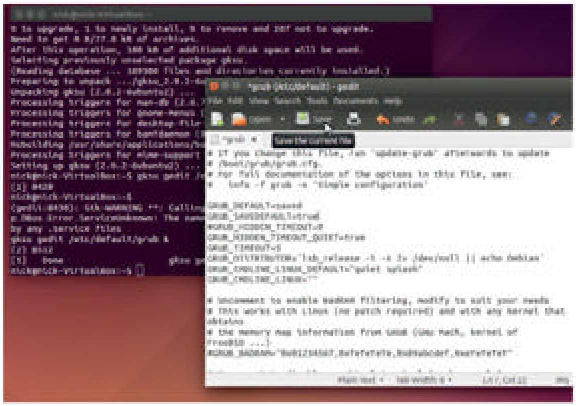
Although you can download programs directly from websites, it's far easier to use the centralized Software Center. Ubuntu provides its own software repository, which is a server containing hundreds of Linux programs specially compiled to work with Ubuntu. This means that any software you find in the Software Center should work without problems, which makes it a little like having your very own Linux app store. The Center also looks out for program updates, alerting you when they're available and installing them for you.

You're not restricted to one app store—sorry, repository—either. Install a program such as Dropbox from its own website, for example, and it'll add its own repo to the Center, enabling it to alert you about updates.

> "If you want to make the most of your new OS, then learning to navigate Terminal is essential."

To manage these repos, open Software Center and select "Edit → Software Sources." A list can be found under the "Other Software" tab, where you can manually add your own.

So far we've not dealt with Terminal, which is Linux's equivalent of the Windows command prompt. While it's technically possible to avoid this, if you want to make the most of your new OS then learning to navigate it is essential.


Configure Grub to choose which OS loads by default.

Opening the Terminal is simple. Press Ctrl–Alt–T. A window appears and, at a superficial glance, it looks a lot like the command line in Windows. In Ubuntu, you start off in the "~" directory, which basically means your personal Home folder. Type "dir" and you'll see a list of folders to confirm this. To change directory, use the "cd" command. To move up a level, type "cd ..," or type "cd home/nick/Pictures" to jump directly to another folder (note that directory paths are case sensitive). You can return to your home directory at any time using the "cd ~" command. Other file-management commands include "cp" (copy), "mv" (move), "mkdir" (create folder), and "rm" (delete file).

One key command you'll need to learn is "sudo." Linux is very tight on security, and in normal day-to-day operations your access is quite restricted. You can't, for example, modify files on your Linux partition outside of your "home" directory. What sudo does is give you elevated access—think of it like right-clicking a program in Windows and choosing "Run as administrator." You can prefix any command with "sudo" to gain this access, but you'll need to provide your password.

You can install software directly from the command line too, using the "apt-get" command. To install GIMP directly from the Terminal, for example, you type "sudo apt-get install gimp." The "apt-get" command can also be used to update all of your existing software ("apt-get upgrade"), check for broken dependencies ("apt-get check"), and fix problems with missing dependencies ("apt-get –f install"). Over time you can also use it to free up disk space by removing Deb packages you've uninstalled ("apt-get autoclean"). It's even possible to download files using the "wget." Just type "wget," followed by the full URL of the file you wish to download, which will automatically be saved to your personal downloads folder.

Now you've successfully installed Ubuntu alongside Windows and grasped the basics of using Linux, there's no turning back. In fact, you'll wonder why you didn't try it before.

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Sony SmartBand Talk review

A smartwatch and fitness combo for those not too bothered about experiencing everything the smartwatch revolution has to offer.

Samsung Gear S review

Samsung made a mini phone in the form of a giant Gear S smartwatch.

Acer TravelMate B115 review

Acer's TravelMate B115 looks to undercut the world of 11" models with price, portability, touch and nothing else.

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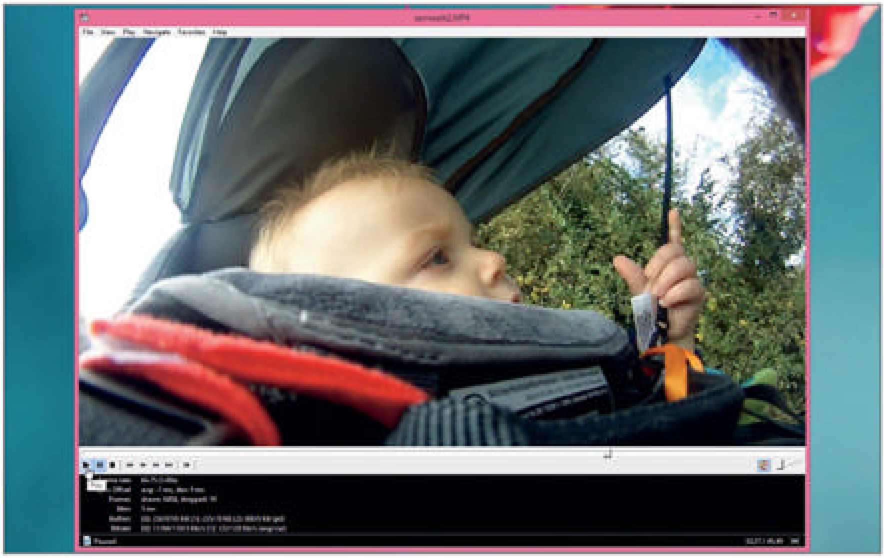
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

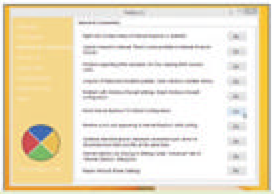
WINDOWS TIP OF THE MONTH



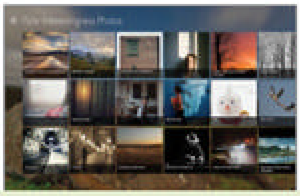
PLAY ANYTHING WITH CCCP

VLC is the go-to alternative media player, but there's a second option—the Combined Community Codec Pack, or CCCP (www.cccp-project.net). Originally developed to play Japanese animé films with subtitles, it's got the necessities to play just about any file, is small, and we've found it more stable than both Windows Media Player and VLC.

MAKE – USE – CREATE



64
Repair Windows with one easy tool



66
Customize the Win8.1 Lock screen

70
Build a PC with two GTX Titan X cards

GRAHAM BARLOW
CONTRIBUTING EDITOR

BANISH BIG BROTHER

Ever get the feeling you're being watched? Well, maybe you are! It should come as no surprise that tools do exist for people to hijack your PC's webcam. The most likely scenario is that it's somebody you know, with physical access to your PC. But there's growing evidence it's also being done remotely by hackers. The FBI recently confirmed it had been doing it for years as a surveillance technique, while, thanks to Edward Snowdon, we know the NSA has been accessing smartphone cameras.

If you never Skype anybody, and this news is making you feel a bit paranoid, simply turn your webcam off. If it's external, unplug it. If it's built into your PC, you'll need to disable it in the BIOS. Reboot your computer and enter the BIOS—usually holding down F2 or DEL does the trick—then look through the options for something like "CMOS camera," or simply "webcam," and disable it. If it's not listed you'll need to boot into Windows and look in Windows Device Manager under "Imaging devices" and disable it there.

Failing that, stick a Band-Aid over the lens. It's a low-fi solution, offering a steampunk aesthetic, but you can be sure you're not being spied on.

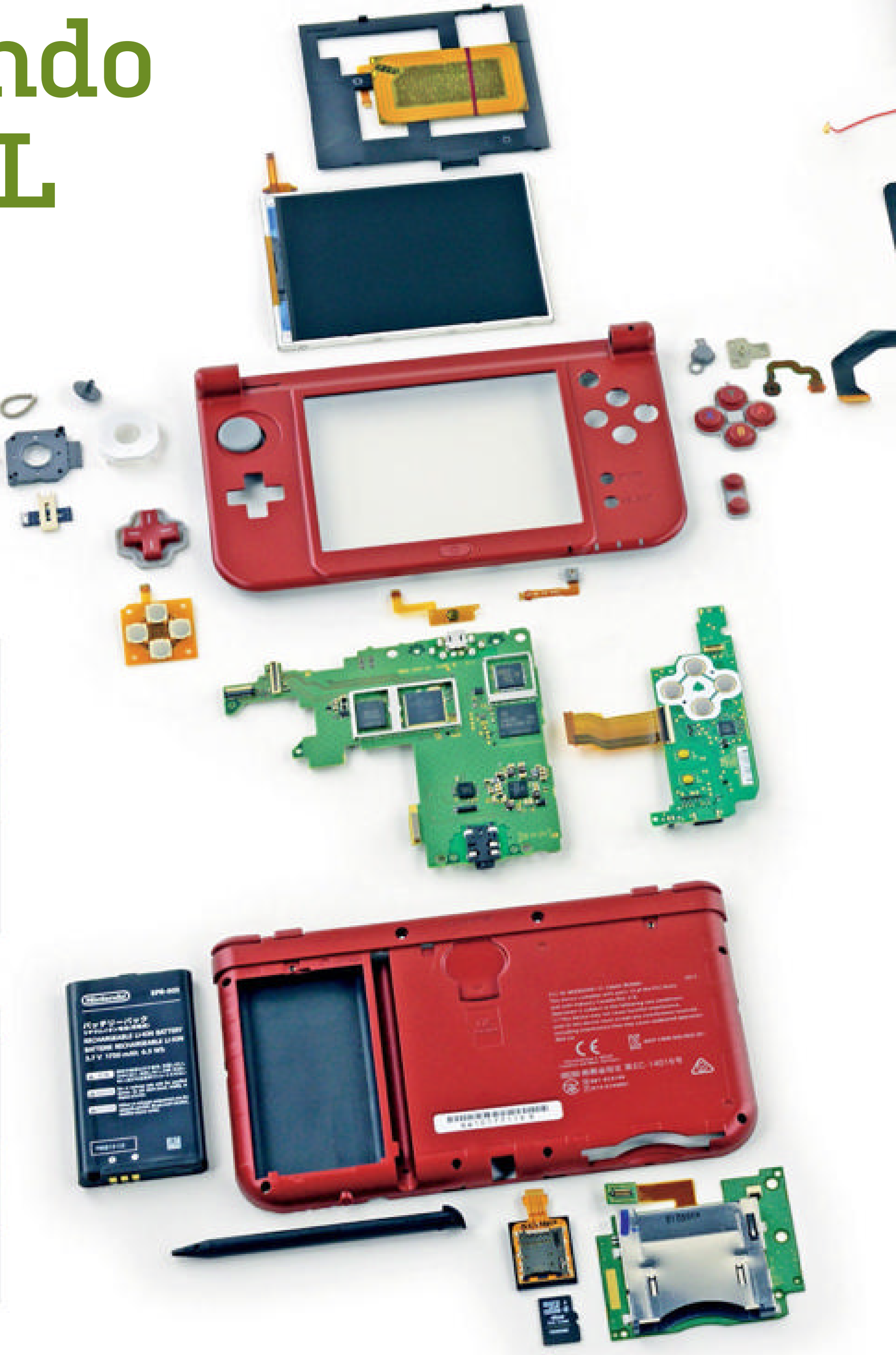
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

AUTOPSY

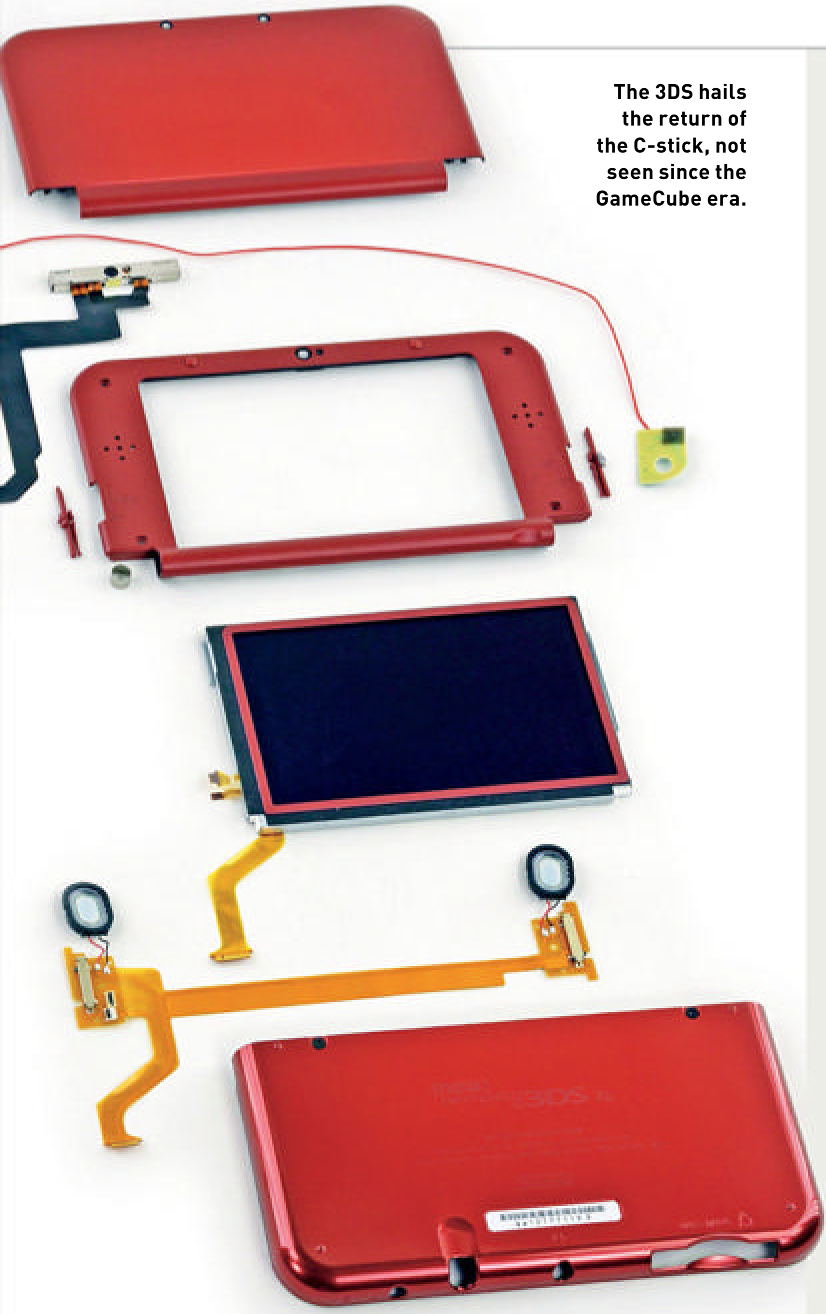
THIS MONTH WE DISSECT...

Nintendo 3DS XL 2015



The display panel's ribbon cable is annoyingly routed through the frame hinge.

Once the cartridge reader is out of the way, it's easy to get at the D-pad buttons.



The 3DS hails the return of the C-stick, not seen since the GameCube era.

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

BACKGROUND:

Give it up for the New Nintendo 3DS XL. We know it's new because it's quite literally called the "New" 3DS XL. We'll call it the 3DS XL 2015 and we kinda wish they had, too. But just how new is it inside? Screwdriver, spudger, and digital caliper at the ready, it's time for the traditional teardown treatment.

MAJOR TECH SPECS:

- Dual screens with resistive touch control
- Main screen with parallax stereoscopic 3D and face tracking
- Upgraded Nintendo 1446 17 CPU
- Atheros AR6014G-AL1C Wi-Fi SoC
- Samsung KLM4G1YEMD-B031 4 GB eMMC NAND
- 3.7V, 1,750mAh, 6.5Wh battery
- Built-in near-field communication (NFC) reader
- MicroSDHC reader

KEY FINDINGS:

- The biggest change from the old 3DS XL is shifting the cartridge slot to the front. The new XL is also a few grams lighter. It's slightly wider but also thinner. And it's shiny!
- To replace the (now micro) SD card or battery, you'll need a screwdriver. Gone are the days of flappy door access. At least they're captive screws. A few more screws and pop goes the back cover. We're greeted with a circuit board and oodles of ZIF connectors. Yet more screws and the mobo pops up, but still with cables attached. Remove the button board and cartridge reader and it's time to free those button covers.
- The top display assembly is only mildly adhered to the frame, meaning we can pop it off with little effort. But its ribbon cable, and two others, are routed through the hinge, and need to be pulled through in a painstaking, risky maneuver.
- The XL's stereoscopic 3D effect is achieved through a combination of parallax filter and new face-tracking "super-stable 3D" tech. The latter means the 3DS knows which pixels each eye can see, and draws two overlapping versions of the same scene—one for each eye.
- Repairability Score: 5 out of 10 (10 is easiest to repair). The good news is the battery is easily swappable by unscrewing two screws and removing the back cover. Screws and plastic clips are the primary fasteners, too, rather than adhesive. Also, no proprietary screw types are used—only Phillips and JIS. On the other hand, the top display's cables are routed in such a way that it makes them quite frustrating to remove without ripping them off, and just as difficult to reseat properly during device reassembly. There are tons of little components inside the 3DS which become loose and are easily lost. The majority of connectors are ZIF, and it's difficult to ensure each one is connected properly without reassembling the whole thing and starting up the device.

Repair Windows With One Easy Tool

YOU'LL NEED THIS

FIXWIN
Download the troubleshooting app for free from http://bit.ly/1BqhQ2R.

FIXWIN IS A SIMPLE TOOL for troubleshooting your Windows installation. You can use the tool to repair more than 50 Windows problems and annoyances that might be caused by malicious malware. Anti-malware scanners can help you remove these harmful programs, but they won't always undo the changes caused by the nasty malware to Windows itself; changes such as hiding the context menu, or disabling the Registry editor.

With FixWin, you can repair these unwanted modifications to Windows. The tool lists all its fixes and their symptoms across several categories. Every problem has a "Fix" button that you can click to apply the suggested solution. It's important to note that FixWin isn't a diagnostic tool - it doesn't search your PC to uncover problems. You have to know you have a problem, and then use this program to fix it. Let's get started. –**MAYANK SHARMA**

1 DOWNLOAD FIXWIN

The latest edition of the program, FixWin 2.0, is designed to resolve issues with Windows 8.1. If you're on Windows 7, stick to version one. Visit http://bit.ly/1BqhQ2R to download the tool and double-click on the executable file to launch the app. FixWin is a portable tool so there's no setup process. This allows you to copy the executable file to any USB drive and run the program on any Windows PC.

2 FIX SYSTEM FILES

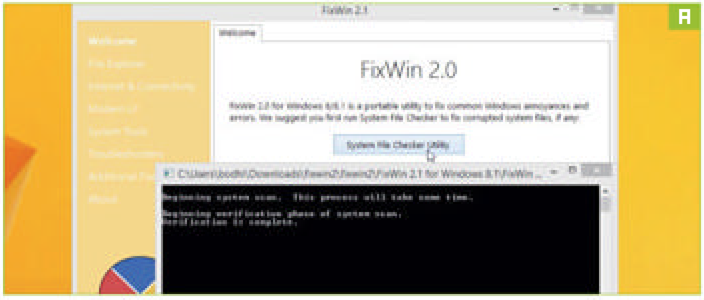
The Welcome screen of the program advises you to first run the System File Checker Utility by clicking the button labeled as such [Image A]. This utility is designed to detect and fix any corrupted Windows system files, help the program assess your PC, and detect possible errors on the drive. Note, this may take some time to complete depending on the size of your disk.

3 CREATE A SYSTEM RESTORE POINT

Once the System File Checker utility has scanned your system, you should create a restore point by clicking on the button. You can continue using the program without a restore point, but it isn't recommended. Since the FixWin solutions are modifying the Windows Registry, a restore point will help revert any changes if the fix introduces unwanted stability issues.

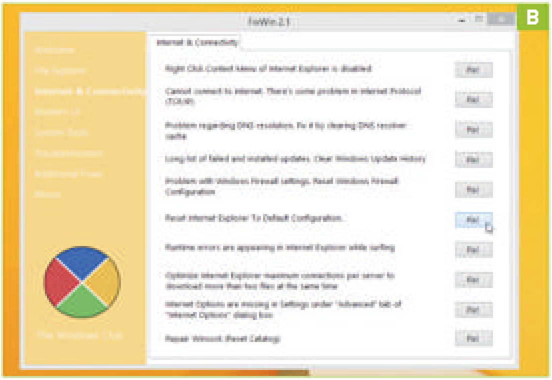
4 FIX FILE EXPLORER

You can now start resolving your PC issues. Click on the "File Explorer" link in the left-hand bar to view all the fixes related to the Windows Explorer. The fixes listed can help restore the Recycle Bin icon to the desktop and the Folder Options settings under the Control Panel. You can also fix the infamous "Class not registered" error encountered when launching apps, from under this section.



```
Beginning system scan.  This process will take some time.

Beginning verification phase of system scan.
Verification is complete.
```



5 RESTORE INTERNET CONNECTIVITY

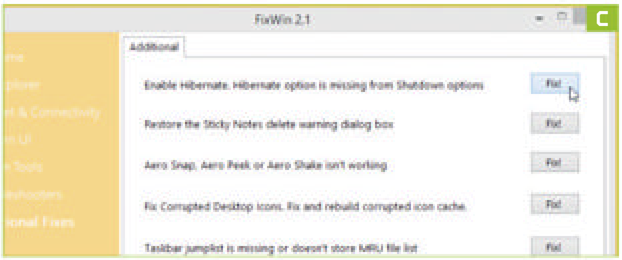
Now switch to the "Internet & Connectivity" section to fix any issues that are related to network connectivity. Here you can get rid of any runtime errors thrown up by IE. You can also reset IE and the Windows Firewall to their default configuration if they've been modified accidentally or by another program [Image B]. There's also an option to optimize IE for concurrently downloading multiple files.

6 FIX WINDOWS STORE

The Windows Store is an essential component to the Windows 8 experience. If you have issues downloading or purchasing apps from here, head to the "Modern UI" section in FixWin. This section lists fixes under two tabs. The "Windows Store" tab resolves issues related to the store. You can clear and reset the store's cache as well as apply fixes to common error messages.

7 FIX SYSTEM TOOLS

Some malware can disable access to Windows tools. FixWin can restore access to these tools and help you take charge of your PC. The "System Tools" section lists fixes around the Task Manager, Registry Editor, Command Prompt, Windows Defender, System Restore, Windows Action Center, and more. This section helps restore access to these tools or reset them back to the default configuration.



FixWin 2.1

Additional

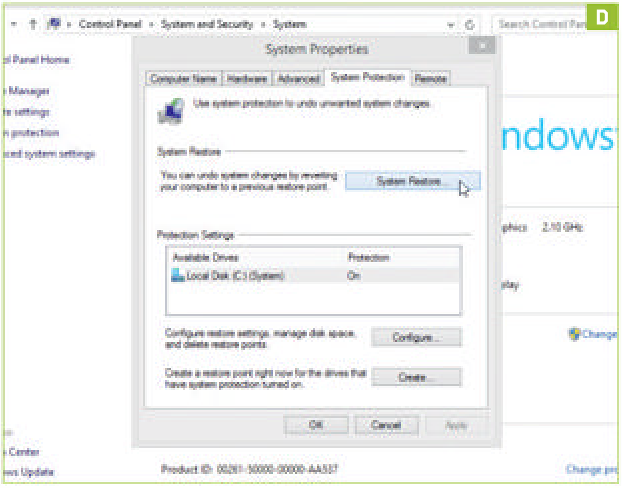
Enable Hibernate. Hibernate option is missing from Shutdown options — Fix

Restore the Sticky Notes delete warning dialog box — Fix

Aero Snap, Aero Peek or Aero Shake isn't working — Fix

Fix Corrupted Desktop Icons. Fix and rebuild corrupted icon cache. — Fix

Taskbar jumplist is missing or doesn't store MRU file list — Fix



Control Panel › System and Security › System

System Properties

Computer Name | Hardware | Advanced | System Protection | Remote

Use system protection to undo unwanted system changes.

System Restore

You can undo system changes by reverting your computer to a previous restore point. — System Restore...

Protection Settings

Available Drives	Protection
Local Disk (C:) (System)	On

Configure restore settings, manage disk space, and delete restore points. — Configure...

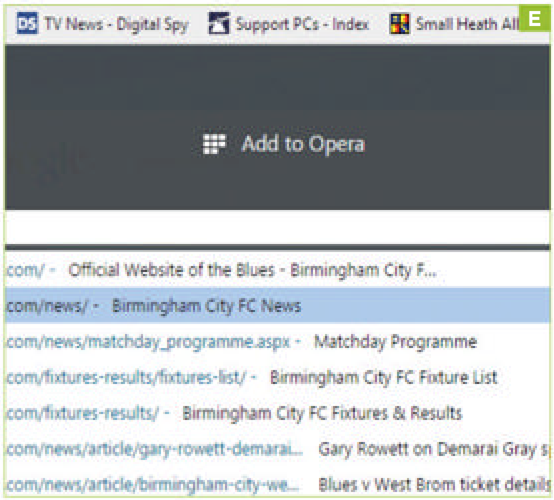
Create a restore point right now for the drives that have system protection turned on. — Create...

OK | Cancel | Apply

Product ID: 00261-50000-00000-AA537

8 MISCELLANEOUS FIXES

Fixes that can't be classified under the other sections mentioned above are listed under the "Additional Fixes" section [**Image C**]. Here you can enable the Hibernate feature if it's missing from the Shutdown menu. You can also fix and rebuild the icons cache if the icons aren't rendering properly, and restore Aero features. This section also helps you prevent Windows Media Player from crashing.



com/ - Official Website of the Blues - Birmingham City F...

com/news/ - Birmingham City FC News

com/news/matchday_programme.aspx - Matchday Programme

com/fixtures-results/fixtures-list/ - Birmingham City FC Fixture List

com/fixtures-results/ - Birmingham City FC Fixtures & Results

com/news/article/gary-rowett-demarai... Gary Rowett on Demarai Gray s

com/news/article/birmingham-city-we... Blues v West Brom ticket details

9 REVERT CHANGES

In the off chance a fix destabilizes your PC, you can restore your computer to its previous state by reverting all the changes made since the previous restore point. Launch Control Panel and head to "System and Security → System." Click on "System Protection" and hit the "System Restore" button in the window that pops open to launch the System Restore wizard [**Image D**].

10 RESTORE SYSTEM

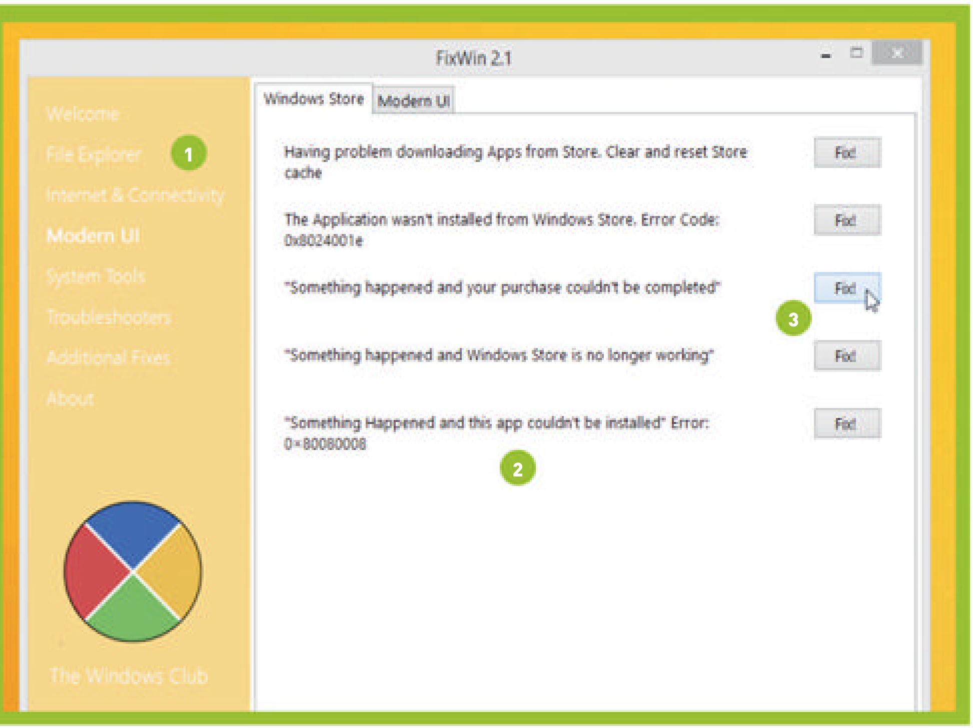
The wizard will show you a list of restore points [**Image E**]. The last system restore point will automatically be selected. If this isn't the one created by FixWin, toggle the "Choose a different restore point" option to list the available restore points. Select the restore point that was created by FixWin and then click on "Finish." This will exit the wizard, restart Windows, and begin the restoration process.

QUICK FIXES

1. CATEGORIES
The various fixes are housed under these categories that represent a particular area of Windows.

2. ERROR ALERT
A brief explanation of the odd behavior that needs fixing.

3. DONE
To apply a fix, simply press this button corresponding to the error you wish to resolve.



Having problem downloading Apps from Store. Clear and reset Store cache — Fix

The Application wasn't installed from Windows Store. Error Code: 0x8024001e — Fix

"Something happened and your purchase couldn't be completed" — Fix

"Something happened and Windows Store is no longer working" — Fix

"Something Happened and this app couldn't be installed" Error: 0×80080008 — Fix

Customize the Win8.1 Lock Screen

THE LOCK SCREEN IS THE FIRST THING YOU SEE IN WINDOWS 8.1, and it should be the first thing you make your own. Fortunately, there's a whole heap of ways you can do just that, from changing the image and color on show, to the type of information updates you receive. You can even set up picture passwords. Likewise with the login screen. From playing around with accessibility, to personalizing your profile picture, there's no reason why your PC experience shouldn't start out exactly how you'd like it to. Read on to find out how. –**MATT HANSON**

YOU'LL NEED THIS

CHAMELEON
Automatically update Lock screen photos with *National Geographic* images with this free, third-party app from the Windows Store.

1 CHANGING THE IMAGE

The standard Lock screen looks pretty enough, but it's even better if you change the picture. Press Windows–I, click "Change PC Settings," and open the "Personalization" menu. The first things you see are your options for replacement images. You don't have to stick with the classy images that Microsoft has provided. You can use a picture of your other half, cat, or favorite pot plant on the Lock screen instead—just click the "Browse" button and choose the image you want to use from now on.

2 EXTRA INFORMATION

At the bottom of the Lock screen you'll see a few quick updates about what's happening on your PC. You can view more than this, though. On the Personalize screen, you'll find options that enable you to change the specific icons that get displayed. Certain apps—Calendar and Weather, by default—can show you more information on the Lock screen [Image A]. Just make sure the app you're interested in is highlighted at the very bottom of the Personalize page of Control Panel.

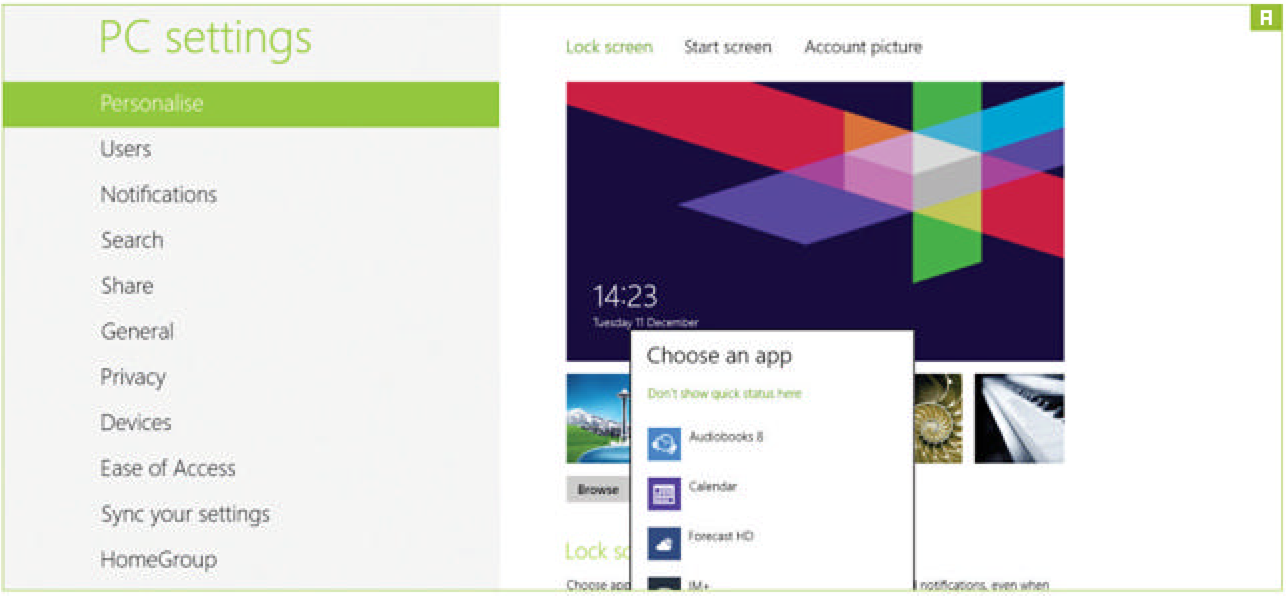
» You can take the Lock screen further with third-party apps. Search the Windows Store for Incredilock. It's free, offers customizable wallpapers, and can add things, such as to-do lists, to your Lock screen. Many apps can add information to your Lock screen beyond those that are installed by default. Hunt through the Windows Store and you should be able to find plenty of apps that you can configure to display useful information at lock; here we're talking about Twitter clients, third-party weather apps, and more.

3 PICTURE PASSWORDS

Open up the Start screen control panel and go to the "Users" tab. Here you can change your login password. Note that changing this also changes it for other machines or services (such as Outlook mail) that your account is linked to. You should try the picture password function on the "Users" tab of "Change PC Settings." It's a fun way to log into your PC, and it's pretty secure, too. Just try not to leave telltale smears if you're using a touchscreen device.

4 FAST LOCK

Want to bring the Lock screen up in a flash if, for instance, you're stepping away from your PC for a while? Easy. Either click your profile picture in the top-right corner of the Start screen and click "Lock," or just press Windows–L at the same time.


A
PC settings
Personalise
Users
Notifications
Search
Share
General
Privacy
Devices
Ease of Access
Sync your settings
HomeGroup
Lock screen
Start screen
Account picture
14:23
Tuesday 11 December
Choose an app
Don't show quick status here
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Calendar
Forecast HD
IM+
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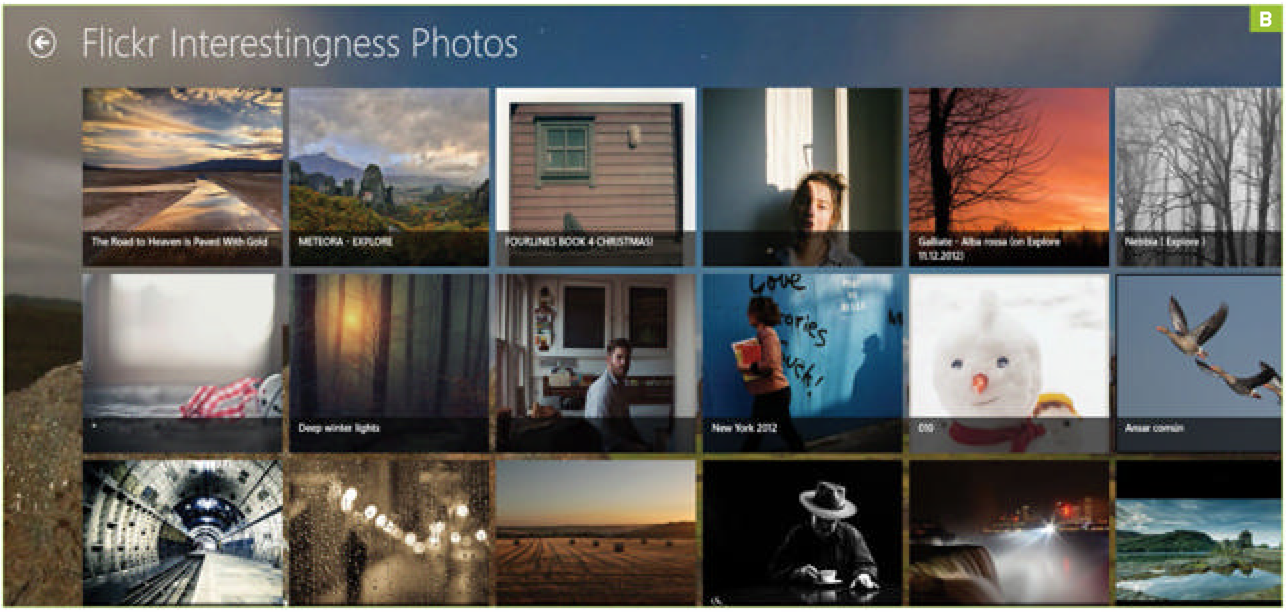

B
Flickr Interestingness Photos
The Road to Heaven is Paved With Gold
METEORA - EXPLORE
FOURLINES BOOK 4 CHRISTMAS!
Galliate - Alba rossa (on Explore 11.12.2012)
Nebbia (Explore)
Deep winter lights
New York 2012
010
Ansar común

5 SCREEN COLORS

You can customize your Lock screen colors separately from your Start screen colors. Open the desktop, hit Windows–R, type "regedit," and go through HKEY_LOCAL_MACHINE, SOFTWARE, Microsoft, Windows, CurrentVersion, Explorer, and then Accent. Right-click on "Accent" and create a new Dword, which we suggest that you call "DefaultColorSet." Now edit this, switch the base to decimal, and set this to be a number between 0 and 24.

6 HIDE SCREEN

If you want to ditch the Lock screen altogether, then hit Windows–R, type "gpedit.msc," go to "Computer Configuration → Administrative Templates → Control Panel → Personalization," and change the option "Do not display the lock screen" to "Enabled."

7 AUTO IMAGE UPDATE

Add some pep to your Lock screen by automatically changing its image. Search the Windows Store for Chameleon. This pulls in photographs from sources such as the *National Geographic* and Bing, and pastes new ones on your Lock screen at set intervals [**Image B**]. Another option for shuffling is Lockerz. This app works by either displaying a selection of your local pictures that you've chosen, or it can be hooked up to your OneDrive account for a truly personal random experience.

8 ONTO THE LOGIN SCREEN

If you just want to get past the Lock screen, to the login screen, there are loads of ways to do that—click it, drag it up, spin your mousewheel, or hit Space to progress. You see your account picture on your login screen. Or you might not. If you've not set one up, you will just see a silhouette. Go to the "Users" menu in "Change PC Settings" to add a picture. This will follow you anywhere you use your Microsoft login.

9 ACCESSIBILITY OPTIONS

The login screen has a neat feature for visually impaired users in the bottom-left, so you can turn on narration, the magnifier, and more, before you log in. Press Tab, then Enter, if you want to get there without clicking. You can also use the accessibility dialog to turn on the onscreen keyboard. It's really useful on touchscreens and for those who can't use a keyboard.

10 QUICK SHUTDOWN

Log out! Shut down! Do it all without logging in. There's an icon at the bottom-right of the login screen that does the job. Access it by tapping Tab, Tab, then Enter, before selecting the function you want with the arrow keys.

11 SHORTCUTS

Once you've logged in, you might want to try getting around the Start screen using nothing but your keyboard. This can be done by using the arrow keys to flick between icons, and Enter to run your selection. Jump through the Start screen by using Page Up and Page Down to hop to either end, or use Tab to jump straight up to your profile picture.

12 MOUSE CONTROL

You can also use the mouse wheel to scroll through your Start screen, particularly if you have a lot of items on there. It is the quickest way to see everything. If you find the amount of apps intimidating, don't worry, simply start typing the name of the app you're looking for and it appears on the right.

13 ALL APPS

Don't forget the "All apps" menu, which shows everything, not just those apps you've got pinned to your Start screen. Right-click on the Start screen and choose its icon. Right-click any of the apps in the "All apps" screen and select "Pin to Start" to make them visible on the Start menu.

14 SWITCH ACCOUNTS

Many people can use the same machine. If you've set up more than one in the "Users" tab of the "Change PC Settings" screen, just click your profile picture to switch accounts.

Secure Your Windows 8.1 PC

YOU'LL NEED THIS

MALWAREBYTES
The anti-malware scanner is available, for free, from www.malwarebytes.org.

MICROSOFT HAS SPENT a lot of time and effort improving the security mechanisms in its OSes, and Windows 8.1 builds on previous releases to protect you against malicious software, such as viruses, spyware, and other nasties. Microsoft's Trustworthy Computing team has outlined the improvements in Win8.1, and broken them down into four categories: trustworthy hardware, modern access control, protecting sensitive data, and malware resistance. The first three are focused on enterprise users, and are geared towards BYOD (Bring Your Own Device) scenarios.

The good news for home users is that Microsoft is also beefing up its built-in malware resistance. For one, Internet Explorer 11 ships with the Enhanced Protection Mode enabled by default, which is designed to safeguard your data even if an attacker has managed to compromise the browser or one of its add-ons. Secondly, Microsoft has also improved its built-in Windows Defender tool. Read on to discover how to make the most of it. **–GRAHAM BARLOW**

1 USING WINDOWS DEFENDER

Windows Defender was upgraded to become a full antivirus program with the release of Windows 8. To bring up the program, type "defender" on the Windows 8.1 Start screen. The colored bar at the top of the Windows Defender interface reflects the protection status of your computer.

» You will see big red warnings if the program has been turned off, or if your database is out of date, while Windows Defender keeps itself updated by automatically downloading new updates to its virus database.

2 STARTING A TAB

The main Windows Defender interface lists four tabs. From the "Home" tab, you can run a quick scan or a full scan by selecting the appropriate button and clicking "Scan now." Alternatively, with the "Custom" button, you can scan specific drives, directories, or even individual files.

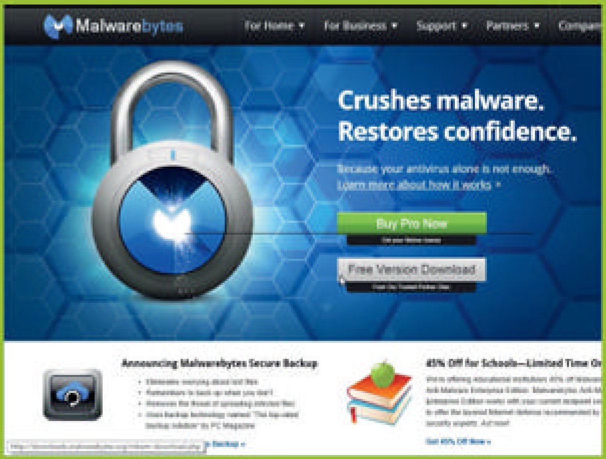
3 GOING INTO QUARANTINE

If Windows Defender finds something objectionable, it moves it into a quarantined area. To view these items, switch to the "History" tab, select the "Quarantined items" radio button and click the "View details" button. This brings up a list of programs that Windows Defender has taken action on, along with the alert level, and the date. From here you can choose to "Remove all quarantined items," or remove them selectively.

4 GETTING OUT OF QUARANTINE

Sometimes Windows Defender might accidentally quarantine a harmless program. In such a case, you can use the "Restore" button to ask Defender to let you continue using the program. This program is now listed as an "Allowed" item, and Windows Defender will not flag the program in future scans.

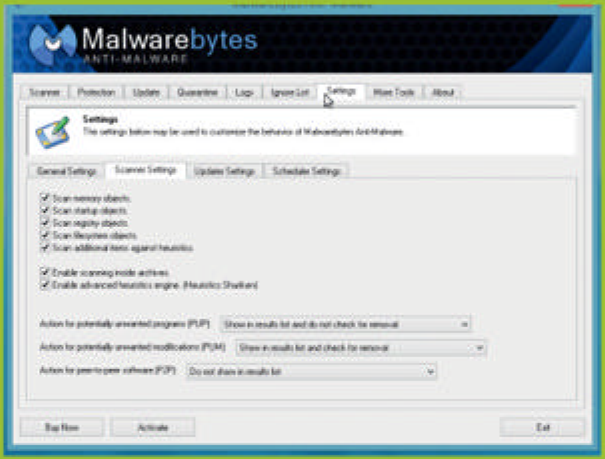
SWITCH TO A FREE ANTIVIRUS PROGRAM



Crushes malware. Restores confidence.

Because your antivirus alone is not enough.
Learn more about how it works ›

1 DOWNLOAD AND INSTALL
Malwarebytes is available as a free download, so pay a visit to www.malwarebytes.org and get it from there. When installing the program on your PC, make sure you uncheck the box that enables the free trial of the Pro version.



☑ Scan memory objects
☑ Scan startup objects
☑ Scan registry objects
☑ Scan filesystem objects
☑ Scan additional items against heuristics

☑ Enable scanning inside archives
☑ Enable advanced heuristics engine (Heuristics Shuriken)

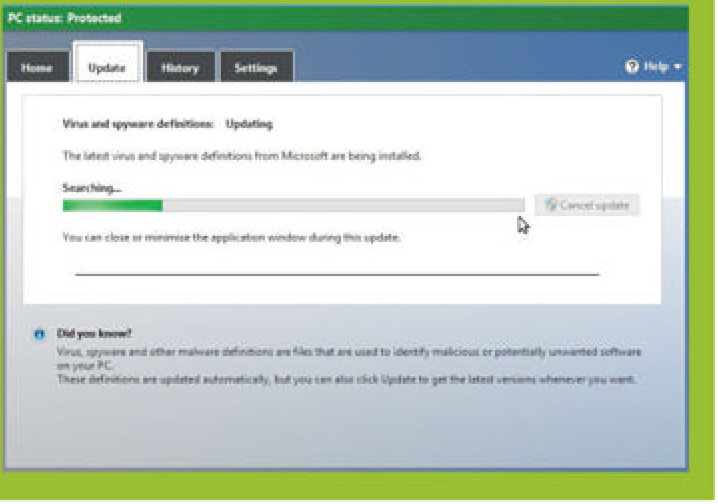
2 REVIEW SETTINGS
The free version of the program doesn't automatically download new malware definitions, so you'll need to update it each time you use it. Switch to the "Settings" tab to tweak the behavior of the program, though the defaults should work for most people.

TAKE ACTION

One important component of Windows 8.1 that plays a crucial role in keeping your computer safe and secure is the Windows Action Center. It monitors the most important aspects of the PC and divides them into two broad categories: security and maintenance. You can find the Action Center located within the desktop Control Panel, under "System and Security."

When something needs your attention, the Action Center flags up the problem. It color-codes any warnings that need your attention. Issues flagged with a yellow border could potentially affect the security or performance of the PC, while a red border is used for highlighting critical problems.

In addition to the color-coding, the Action Center also displays a description of the problem, along with a link to open the configuration window of the relevant tool to resolve the issue.



Virus and spyware definitions: Updating

The latest virus and spyware definitions from Microsoft are being installed.

Searching...

You can close or minimise the application window during this update.

Did you know?

Virus, spyware and other malware definitions are files that are used to identify malicious or potentially unwanted software on your PC.
These definitions are updated automatically, but you can also click Update to get the latest versions whenever you want.

5

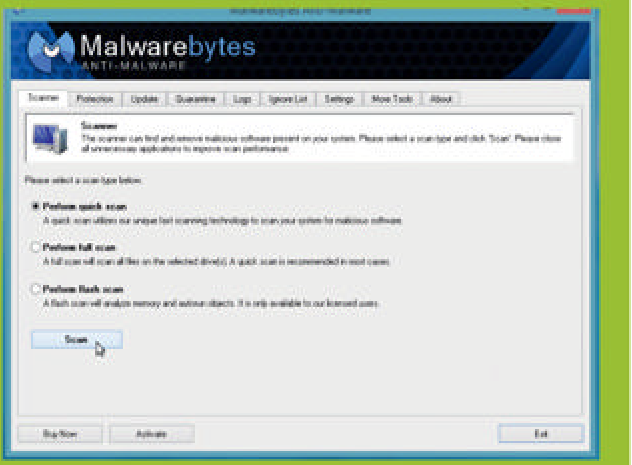
DEALING WITH MALWARE

Windows Defender does a good job of keeping your system clean, but if you're particularly paranoid about malware, you can use a dedicated anti-malware scanner, such as Malwarebytes (see "Switch To A Free Antivirus Program," below). However, there's a certain type of malware, known as a worm, which specializes in spreading over the network. Having a well-configured firewall is an essential safeguard against this type of malware. It also protects you against attackers trying to sneak into your computer and attempting to exploit the network capabilities of trusted programs.

6

WINDOWS FIREWALL

Windows Firewall is designed to block unwanted and potentially dangerous connections. Remember how Windows prompts you to choose whether a new network is a home, work, or public network? If you choose a public network, where your computer could be a sitting duck for a network attack, the Windows Firewall blocks almost all incoming connections in order to dissuade attackers.



3 SCAN

From the "Scanner" tab, you can perform either a quick scan of your PC, or a full scan, which is more thorough and takes a fair bit of time to complete. The third type of scan offered, flash scan, is only available to licensed users.

7

TWEAKING THE FIREWALL

For the most part, there's no need to configure the Windows Firewall. Most programs that need to listen for incoming connections automatically tweak it to allow such connections during installation. However, Windows does allow users to manually configure the firewall. To bring up the Windows Firewall controls, type "firewall" on the Windows 8.1 Start screen. You'll notice several options in the main interface of the Windows Firewall.

» The "Allow an app or feature through Windows Firewall" option gives you a list of network-aware programs installed on your PC.

8

SHARING IS CARING

Along with these programs are details of whether they're allowed to communicate over private and public networks. Private networks allow sharing, while public networks are those over which sharing is restricted.

9

STAYING ALERT

To change the settings for a program, click "Change settings," then adjust your options. With "Change notification settings," you can tweak how the Windows Firewall alerts you—for example, when a new program is blocked—for both public and private networks. You also get options to either completely block incoming connections, which prevents you from even browsing the Internet, or to turn off the firewall altogether.

10

RESTORING DEFAULTS

If you wish to tweak Windows Firewall in greater detail, click on the "Advanced settings" option. Here you can control network traffic by creating firewall rules. For example, you can restrict traffic to specific ports and from specific IP addresses.

» Although incorrect modifications to the Windows Firewall can isolate your computer from the network, don't be afraid to experiment. You can always select "Restore defaults" and revert to the original settings. ⏻

BUILD IT

TOM MCNAMARA **TECHNICAL EDITOR**

Double Trouble: X Marks the Spot

Dual Nvidia Titan X cards await within this treasure chest

LENGTH OF TIME: **1–3 HOURS** LEVEL OF DIFFICULTY: **MEDIUM**

GEFORCE GTX
GEFORCE GTX
CORSAIR

THE MISSION

OVER THE PAST SIX MONTHS or so, we've seen an impressive new slate of hardware arrive on store shelves, from Intel's Haswell-E generation of workstation CPUs sporting 6–8 cores, to futuristic-looking cases from Corsair, to the return of Nvidia's flagship GPU in the guise of the GeForce GTX Titan X.

We decided it was high time to bring this all together, while also checking out the viability of an older power supply and a new closed-loop liquid CPU cooler from Silverstone. To a degree, this is an "out with the old, in with the new" kind of build, where we bid farewell to a venerable piece of gear that's been eclipsed, while embracing the future of enthusiast gear.

We usually build with parts that have been released roughly within the past year, but not everyone is so fortunate. And sometimes you have equipment that's a little long in the tooth but still works fine. Might as well integrate it into a new build, right? And as we learned, the "old" stuff can still scale to handle cutting-edge gear, though the margin can get pretty thin.

HERE BE DRAGONS

AS MUCH AS WE LIKE the portable form factor of a Mini-ITX case, a full-tower like the Corsair Graphite 780T is more forgiving. It also looks pretty cool. Since our power supply uses rounded cables, we need a little more leeway than usual for cable management (most vendors are moving to flat cables, which take up less space). Our PSU is the well-regarded Silverstone Strider Gold, which came out about three years ago. This 1,200-watt version can supply up to eight PCI Express cables, so it's pretty expandable. The unit is also relatively compact, with a length of only 7 inches. For reference, the Corsair AX1200 is 8 inches long. Compactness has long been a hallmark of Silverstone PSUs, and it's something we've often relied on.

We've paired our videocards with the Intel Core i7-5820K. This one has six CPU cores. It's slotted into an Asus X99-A/USB 3.1 motherboard. As its name implies, it has integrated USB 3.1 ports, and it can do NVM Express as well. Last but not least is the 240mm Silverstone TD02-E closed-loop CPU cooler, which is a recent update of the original TD02. Also in the mix is a 1TB 840 EVO we wanted to give one last run, and 16GB of 2,800MHz Corsair Vengeance low-profile DDR4. We opted to not put a hard drive in this particular system, since we almost never use them in Build It.

INGREDIENTS

PART		PRICE
Case	Corsair Graphite 780T	$176
PSU	Silverstone Strider Gold 1,200W	$300
Mobo	Asus X99-A/USB3.1	$280
CPU	Intel Core i7-5820K	$380
GPU	2x Nvidia GeForce GTX Titan X	$2,000
RAM	4x 8GB Corsair Vengeance DDR4	$660
SSD	1TB Samsung 840 EVO	$440
OS	Windows 8.1 64-bit OEM	$100
Total		$4,336

1

THAR SHE BLOWS

WE'VE COME TO ENJOY these handy fan grills that pop out really easily when you give the top corners a simple click. Once you've experienced them it's hard to go back to the days of wrenching off the front of a case in order to access fan mounts and drive bays. Behind this grill, we then discover two pre-installed 140mm intake fans, which glow bluish-white when powered up. You've also got the option to mount three 120mm fans, or one 200mm fan.

If you remove the drive cages found just behind these fans, you can also install a variety of radiators, all the way up to 360mm. The cages are just screwed in—there's no need to reach for the hacksaw. These fans can plug into the case's integrated fan controller, which we'll talk about further on.

2

BATTEN YOUR HATCHES

THE 780T ALSO HAS A CLICKY GRILL on the top. Below is a recessed set of fan mounts, so you can put fans up here without obstructing things inside the case proper. This spot will take three 120mm fans, or two 140mm fans. If you have a 25mm radiator, there's enough space for "push-pull," which puts fans on both sides of the rad.

We installed the Silverstone cooler's fans below the rad, to reduce noise. This required mounting the rad with some longer screws than those provided, because the 780T's mounting holes are padded with rubber grommets whose thickness adds another 3mm or so. Luckily, you can get inexpensive machine screws in a variety of lengths from a home improvement store. Take the shorties to act as visual aid.

3

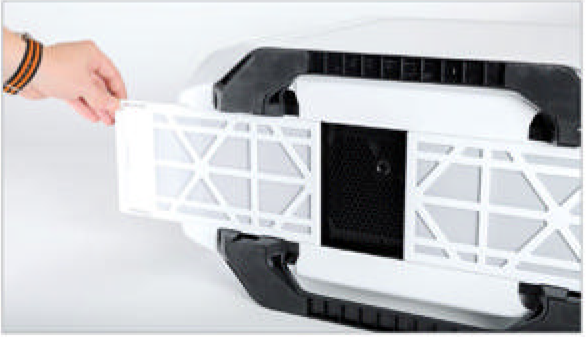
CHECK YOUR RIGGING

THE 780T'S INTEGRATED fan controller has four connectors (three shown here, because we're using three case fans), and they're all within easy reach of the case's pre-installed fans. Sometimes the rear exhaust fan's cable isn't long enough, but that wasn't a problem here. The controller itself is powered via a SATA cable, so make sure you have an extra when building with this case. It has three speeds, but these fans didn't get loud even when maxed out. The controller is handy because it frees up your motherboard's connectors for additional fans. We also note the connectors here are industry-standard 4-pins, instead of being proprietary.

4

ANCHORS AWEIGH

AS HAS BECOME COMMON on the high end, the 780T's undercarriage has some niceties, as well. Down here, we have not one but two dust filters that can slide out for easy cleaning or replacement. Observant readers may also note the fan mounting holes peeking out. The bottom of the case has one 120mm fan mount that's immediately accessible, and another 120mm when you remove the lower drive cage, which means you have space for a 240mm radiator. That's useful for a water-cooling loop attached to a videocard. This case has some impressive airflow potential. The black ABS plastic feet on either side of these filters elevates the case about one inch off the floor, giving your power supply's intake fan plenty of clearance to get cool external air. Each corner of the feet is also rubberized for stability.



5

THE POOP DECK

NOT THE CLEANEST WIRING JOB we've ever done, but that was kind of the point. We wanted to demonstrate how messy things could get, while still allowing the side panel to go on without any effort. We've six rounded power supply cables coming through, a SATA data cable, three fan cables, a variety of front panel cables, and even cables from the CPU cooler mounted in the top of the case, which we tucked back here just to make things look nice and clean up front.

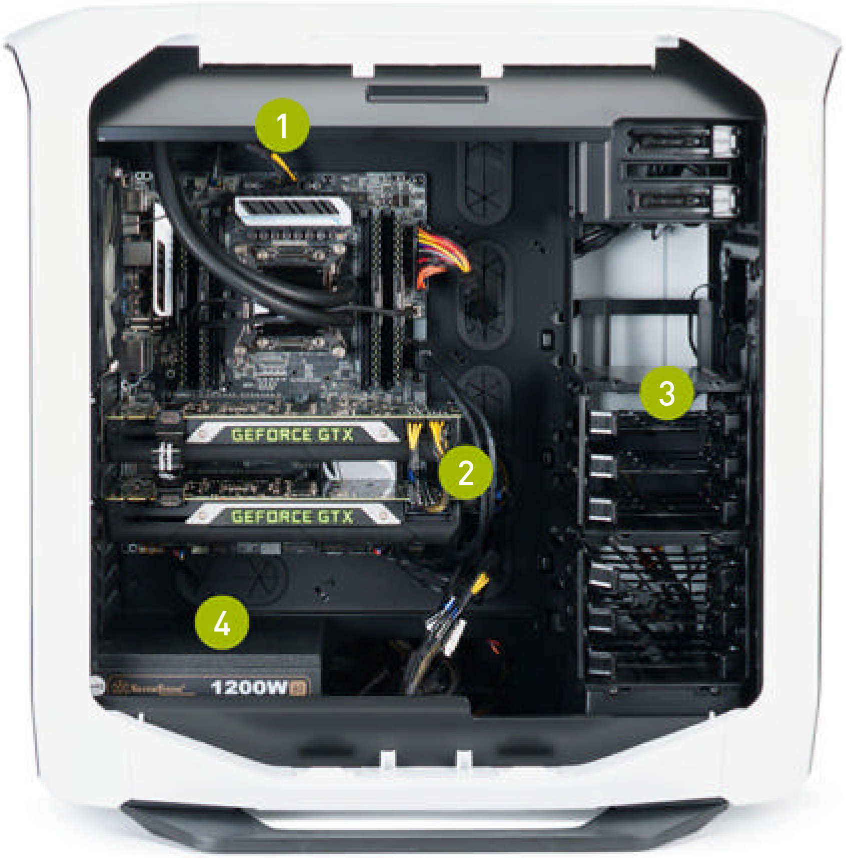
The Strider Gold's 24-pin motherboard cable was just barely long enough, but we had no trouble with the 8-pin power cable that went to the upper right-hand corner. The SATA power cable had to terminate at a 90-degree angle to fit into the back of the SSD, but that's not unusual. Once we were done back here, the toolless side panel just angles in at the bottom and snaps shut at the top. To remove it, just pull the handle and lift it away.

6

IN THE CROW'S NEST

IN CASE YOU HAVEN'T SEEN how the 2.5-inch drive trays work, here's a close-up. It's another toolless container, where you just slide the drive in from the side. The tab at the bottom snaps in when the drive has slid all the way to the left. The installation of the tray is also toolless. There's a bracket mechanism on the other side of this tray that snaps in. It can be a little tricky to put it back in once you've taken it out. We recommend a flashlight and some patience.

There are usually four of these trays in the back, but we removed the bottom-most one to make room for our cabling shenanigans. Admittedly, these trays are not snug. That's fine for an SSD, which has no moving parts. If you're using a 2.5-inch mechanical drive, the top of the tray has two screw holes to create a tighter fit. Whichever type of drive you choose, we recommend a flat SATA data cable if you need to face the drive outward like we did.



① Thanks to the height of this case, the radiator and fan disappear completely inside this upper shroud.

② With one PCIe cable removed, you can more clearly see that we're only using two of them, thanks to this cable design.

③ We left the drive cages in so that you could visualize how much space a 10.5-inch card takes up. The 780T is deceptively large.

④ Based on its size, you wouldn't think that this PSU could put out 1,200 watts. But Silverstone is known for compact designs.

LAND HO!

YOU MAY HAVE HEARD that the Intel Core i7-5820K has fewer PCI Express lanes than the other Haswell-E CPUs, and that's true. But 28 lanes is still more than two videocards know what to do with, so we don't need to bump up to the 5930K, which would also cost us another couple of hundred dollars. Of course, we're already blowing two grand on our videocards, but we had multiple reasons for that. Besides having top-end performance, these cards also draw a healthy amount of power. We're also overclocking our hex-core CPU from a base clock of 3.3GHz to 4.2GHz, on all cores. And there are five case fans in this system. This combination of parts gives us a solid testing environment to see how this 3-year-old power supply still handles itself. Like we were hoping, it didn't break a sweat, and its fan made hardly any noise.

Sadly, this PSU can't be a mainstay any longer, because its PCI Express cables have a total of "only" four 8-pin connectors. Reference versions of a card like the Nvidia GeForce GTX 980 use two 6-pin connectors and seem to signal lower requirements than we've seen before; vendors can produce cards like the MSI Gaming 4G, which requires two 8-pin connectors. This PSU's combined PCIe cabling is nice, though. Each has both an 8-pin and a 6-pin connector. So if the card doesn't need more cables than that, you only need one per card. That helps with cable management and makes the case interior look cleaner.

The company's TD02-E closed-loop CPU cooler, meanwhile, came out earlier this year. Despite having to cool six Haswell-E cores running 900MHz faster than their base clock, our temps never got above 72 degrees Celsius. You could definitely hear the fans working to keep things cool, but it was never distracting. Part of this is thanks to the radiator's dense fin array, and that requires fans capable of moving a lot of air, but Silverstone is no slouch in the fan department either. The two bundled units are rated to move up to 92.5 cubic feet per minute. For reference, the Corsair H100i is rated to move up to 77 CFM. For an 8-core CPU, we'd still recommend at least the H110i GT, if not custom water cooling. But the TD02-E did impressively well with our respectably overclocked i7-5820K. Overall, we enjoyed building this rig and finding out what this gear was capable of. ⏻

BENCHMARKS

	ZERO-POINT	
Premiere Pro CS6 (sec)	2,000	1,571 (27%)
Stitch.Efx 2.0 (sec)	831	749 (11%)
ProShow Producer 5.0 (sec)	1,446	1,384 (5%)
x264 HD 5.0 (fps)	21.1	26.9 (28%)
Batman: Arkham City (fps)	76	206 (271%)
3DMark 11 Extreme	5,847	13,034 (223%)

0% 25% 50% 75% 100% 125% 150% 175% 200% 225% 250% 275%

Our current zero-point consists of a hexa-core 3.2GHz Core i7-3930K 3.8GHz, 8GB of Corsair DDR3/1600, on an Asus Sabertooth X79 motherboard. We are running a GeForce GTX 690, an OCZ Vertex 3 SSD, and 64-bit Windows 7 Professional.

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New technologies.

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TESTED. REVIEWED. VERDICTIZED.

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GEFORCE GTX

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Intel NUC5i5RYK

Need Ultrabook components in a tiny desktop?

WE KNOW THIS is essentially a desktop machine and, yes, it has a Broadwell i5 processor in there, but this doesn't mean Intel's newest CPU generation has actually made its way out of the low-power, mobile mindset. Gigabyte's latest BRIX S *is* rocking a new fifth-generation Core processor, but this is from the mobile U-series that Intel launched at January's CES.

Intel's quasi-barebones NUC PC is back for round three, with the snappily named "NUC5i5RYK" SKU leading the charge. Equipped with Intel's i5-5250U dual-core CPU, clocked at 1.6GHz, the processor still comes soldered to the NUC's motherboard. And once again, owners will have to bring their own OS to the party.

In terms of form factor, the NUC remains extremely portable, measuring 4.5 x 4.3 x 1.3 inches and weighing a pound, four ounces. As well as the new Broadwell proc, there are several upgrades to the NUC5i5RYK. It now supports up to 16GB of 1,866MHz SO-DIMM RAM, which is definitely appreciated, considering the old NUC D54250WYKH SKU only supported 1,600MHz RAM. For the purposes of this review, Intel provided us with 8GB of HyperX DDR3L RAM clocked at 1,600MHz. This NUC also does away with both SATA and mSATA slots and replaces them with the faster M.2 standard. Our test sample also came with its own 530 series M.2 SSD and Samsung's more expensive XP941 series 256GB drive. One last bonus is an 802.11ac and Bluetooth 4.0 combo adapter.

Considering Broadwell is a "tick" on Intel's tick-tock roadmap and equates to a new 14nm manufacturing process, our CPU is focused more on power efficiency than pure performance gains. Oddly enough, however, we saw a bit of the reverse in our tests. This NUC5i5RYK soaked up roughly one watt less at idle than the D54250WYKH Haswell NUC we reviewed last year, but consumed roughly five more watts when we stressed it under Prime95 and Furmark. Thankfully, this Broadwell NUC made up for it in performance, where it bested its Haswell cousin by roughly 7 to 10 percent in our CPU benchmarks.

SPEEDY STORAGE

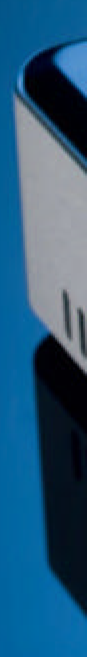
While the CPU gains were admirable, we saw a bigger delta in our graphics benchmarks. The NUC5i5RYK uses Intel's HD Graphics 6000, and while it doesn't hold a candle to the Gigabyte Brix Pro we reviewed last year, which uses Intel's top-of-the-line Iris Pro graphics, it's a step up from Intel's HD Graphics 5000 series, beating it by 10 to 45 percent in our tests.

Considering the box is quite small, you might wonder how hot or loud it gets. When it's sitting idle, it's both cool and quiet. Under the onslaught of our benchmarks, however, the fan did rev up, but it was hardly offensive. The box also got a little warm to the touch, but nowhere near as scorching as the Gigabyte Brix Pro, which is an enthusiast NUC gunning for performance.

The real story here pertains to the included M.2 slot, which allows for some ridiculous storage speeds. With Intel's 530 Series M.2 SSD installed, we saw sequential-read and -write speeds of 419MB/s and 213.6MB/s, respectively, using our CrystalDiskMark benchmark. Those numbers aren't super impressive, but considering a 180GB drive will run you $105, it isn't a super high-end SSD either. When we plopped in Samsung's more expensive ($254) XP941 256GB M.2 drive, however, we got stupid sequential-read and -write speeds of 1,089MB/s and 798MB/s, respectively. Your grandmother's traditional 2.5-inch SSDs can't touch those numbers, as they're limited to SATA III's 6Gb/s bandwidth cap. The downside of M.2 SSDs at the moment is that they aren't as plentiful as traditional 2.5-inch SSDs, and are still quite expensive.

If you can stomach the extra cashola the M.2 slot currently demands, you'll appreciate some of the tweaks this NUC brings to the table. The included Bluetooth and Wi-Fi are great, and we like that you can stuff speedier RAM in the box. But like other NUCs, we still feel it's going to be a pretty niche product at the end of the day.

It's certainly not hard to build into, and could be a good first step for the noob PC builder. That said, you have to purchase your own storage, RAM, and OS, plus install all the drivers yourself, which may turn off PC noobs from picking up what is essentially a pretty cool Ultrabook tossed into a very small desktop form factor. **–JIMMY THANG**



VERDICT 8

Intel NUC5i5RYK

+ NEXT UNIT OF COMPUTING Wi-Fi and Bluetooth wireless combo is nice; M.2 slot opens up speedy storage opportunities; now supports 1,866MHz RAM.

− PAST UNIT OF COMPUTING No SATA slot; M.2 storage drives are still pricey.

$400, www.intel.com

SPECIFICATIONS

CPU	Intel's i5-5250U
Graphics	HD6000
Ports	Mini HDMI 1.4a, DisplayPort 1.2, 4x USB 3.0, gigabit Ethernet, analog audio out, IrDA, Kensington lock port
Storage Support	M.2

BENCHMARKS

	Intel NUC5i5RYK	Intel NUC D54250WYKH
Stitch.Efx 2.0 (sec)	**1,594**	1,764
Proshow Producer 5 (sec)	**2,391**	2,562
3DMark Cloud Gate	**5,466**	4,750
3DMark Ice Storm	**52,185**	47,400
Counter Strike: Source (fps)	**102**	63.3
Power Consumption Idle (watts)	**4**	5
Power Consumption Prime95+Furmark (watts)	28	**23**
Power Consumption 1080p Video (watts)	14	14

Best scores are bolded. The Intel NUC D54250WYKH is included for reference. We tested with 8GB of DDR3/1866 and Windows 8.1.

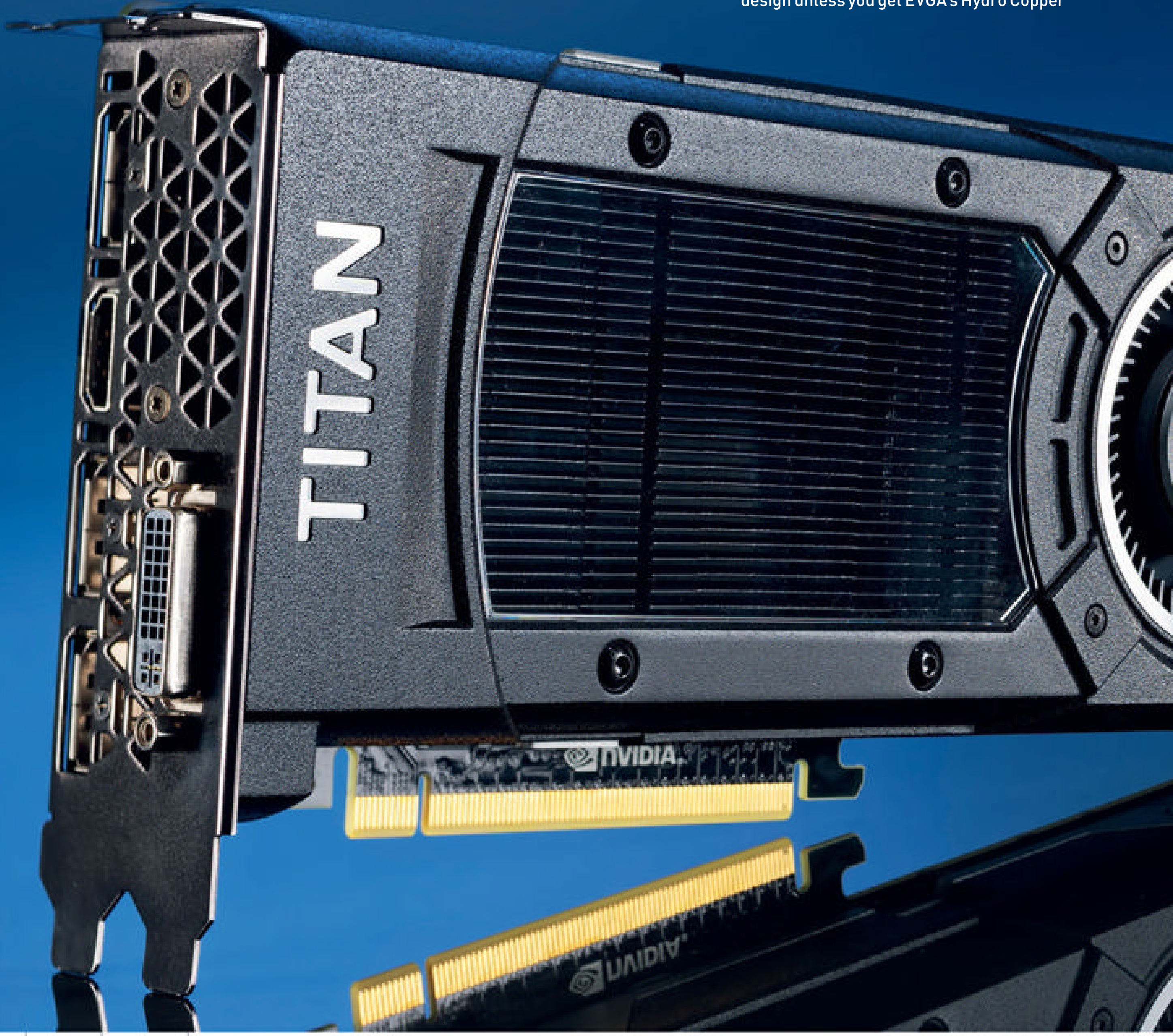
M.2 is the only storage option available here.

Nvidia GeForce GTX Titan X

IN ANCIENT GREEK MYTHOLOGY, the Titans are the immediate descendants of the primordial gods. So it is with the Nvidia GeForce GTX Titan, offspring of the company's top-shelf professional workstation GPUs. First debuting in March 2013, the original Titan was nearly the most powerful videocard Nvidia could offer. But it sealed off a couple of items of little interest to gamers, items which also prevented professionals from using these less expensive variants for workstation duties. Now the time has come for the GTX Titan X, based on Nvidia's Maxwell generation of GPUs. And it's a beast. Despite being stuck on 28nm for several years, the firm continues to extract more and more performance from its silicon. The Titan X also has an almost ridiculous 12GB of GDDR5 VRAM, and one billion more transistors than the original Titan.

Yet it still draws about 250 watts under load despite higher clock speeds, and its cooler is noticeably quieter. Despite all the silicon, it still uses Nvidia's reference dimensions; it's only about 10.5 inches long, and it's not taller or wider than the slot bracket. If not for its darker coloring, you could easily confuse it for any baseline Nvidia card from the past couple of years. Its FP64 performance has been cut to the bone, though. So now more than ever, the Titan X is an executive-class gamer card.

Unfortunately, like earlier Titans, Nvidia won't allow vendors to use their own coolers, so you're stuck with this reference design unless you get EVGA's Hydro Copper



A new hero descends from Mount GeForce

version, or you try something like an Arctic Cooling Accelero Hybrid.

We've been testing with a mix of AMD-friendly and Nvidia-friendly titles (it seems you're either one or the other, these days)—*Metro: Last Light*, *Hitman: Absolution*, and *Tomb Raider* usually favor AMD; *Batman: Arkham Origins*, *Shadow of Mordor*, and Unigine Heaven favor Nvidia. In all cases, we use their built-in benchmarks.

THE CHOSEN ONE?

The cards we tested the Titan X against all comfortably sustain 60-plus fps at 1080p, but older GPUs struggle to maintain that threshold at 2560x1440, as does the GTX 970. We're pushing 77 percent more pixels onto the screen, and the original Titan's relatively low number of ROPs, low clock speeds, and Kepler-gen CUDA cores combine to make an obstacle that the other cards don't have to deal with. The new Titan X is producing well over 50 percent more frames than the original Titan in some of these tests. Wringing these kind of gains from the same 28nm process is pretty impressive. It comfortably beats AMD's best card in every test.

We want to see how these cards perform when pushed to the limit, not just playable frame rates. Despite these demands, the Titan X remains a viable solo card to have at 4K, though it's still not ideal (putting aside the technical resolution difference between DCI 4K and Ultra HD 4K). The good news is that 4xMSAA is arguably not needed at a resolution this high, unless you're on a big 4K HDTV a couple of feet away.

Overall, things are looking rosy. Since it's packed with a huge amount of render output units, streaming multiprocessors, CUDA cores, and VRAM, the Titan X can overcome the limitations of the aging 28nm process. The Maxwell-generation CUDA cores are also about 40 percent faster than the older Kepler version (by Nvidia's estimation, at least). It's not the Chosen One if you want to game with a single GPU at 4K, but you can get pretty close if you're willing to tweak a few graphical settings.

–TOM MCNAMARA

The Titan X has an HDMI 2.0 connector, which can do 4K at 60Hz.

SPECIFICATIONS

GPU	GM 200
Lithography	28nm
Transistor Count	8 billion
Die Size	601mm²
SMM Units	24
CUDA Cores	3,072
Texture Units	192
ROPs	96
Base Clock	1,000MHz
Boost Clock	1,075MHz
Memory Capacity	12,288MB GDDR5
Memory Bus	384-bit
Memory Clock	3,505MHz
TDP	250W

VERDICT
9
KICK ASS!

Nvidia GeForce GTX Titan X

+ GIN AND JUICE Warp-speed performance; piles of VRAM; compact and fairly quiet.

− PURPLE DRINK Steep price tag; limited cooling options.

$999, www.nvidia.com

BENCHMARKS

	Metro: Last Light	Batman: Arkham Origins	Hitman: Absolution	Middle-earth: Shadow of Mordor	Tomb Raider	Unigine Heaven
GTX Titan X	**64/35**	**90/53**	**60/33**	**77/44**	**129/60**	**61/26**
GTX Titan	44/24	58/34	43/22	49/25	77/37	38/18
GTX 980	59/32	71/41	46/24	67/37	105/48	48/20
GTX 970	47/24	59/32	39/19	51/28	81/37	36/15
GTX 780 Ti	51/27	62/38	48/23	56/32	86/40	42/19
GTX 780	47/26	59/35	44/23	52/30	80/38	40/18
Radeon R9 290X	54/28	83/41	54/29	63/37	91/43	40/17

Best scores are bolded. Results are fps at 1440p, followed by 4K. Our test bed is a 3.33GHz Core i7-3960X Extreme Edition in an Asus Rampage IV Extreme motherboard, with 16GB of DDR3/1600, and a Corsair AX1200. The OS is 64-bit Windows 8.1.

Future

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Crucial BX100 1TB

The flagship of Crucial's new budget-oriented BX100 range

THE LAST TIME Crucial launched an SSD, the extremely popular MX100 series, it basically decimated the market in terms of pricing. And now it's back to pick over the bones with a drive very much aimed at the budget end of the market, the MX100's lovechild, the BX100.

A quick glance at the price tag of this flagship 1TB drive makes you stop and think. Could anyone 18 months ago have predicted a 1TB SSD for a fistful of dollars under 400 bucks? The market has come a very long way in a very short time.

At roughly $15 or so cheaper than Samsung's latest 1TB 850 EVO, the BX100 1TB is the cheapest 1TB class drive currently available (at time of writing). Admittedly the 850 EVO does have better quoted read speeds and much better write speeds than the BX100, but then even Crucial admits (which must be a first for a manufacturer) that the BX series isn't the fastest drive available on the market. Instead, the company claims to have aimed for a more balanced approach to performance and value.

MEET THE FAMILY

The 1TB drive is joined by 120GB, 250GB, and 500GB capacities, all with quoted 535MB/s sequential read speeds. Sequential write speeds are a different matter. The 500GB and 1TB models are both rated at 450MB/s, while the 250GB drive manages 370MB/s, and the 120GB drive scrapes in with a lowly 185MB/s.

Perhaps the most surprising thing about the BX100 series is the choice of controller. Gone is the usual Crucial first choice of a Marvell chip. In its place is a four-channel Silicon Motion SM2246EN. It's the first time this controller has seen the light of day in a Crucial drive. Alongside the controller in the 1TB drive are 16 16nm Micron 128Gb NAND packages (eight per side) together with 512MB of DDR3 cache (in two 256MB chips).

As befitting its budget status, the BX100 range doesn't come with any hardware-based encryption, or indeed any of the other fancy bits and bobs that previous drives had. And, although it can monitor its internal temperatures, it doesn't have the thermal throttling technologies of previous drives either.

COMPARE AND CONTRAST

So how does that Silicon Motion controller do against the more familiar Marvel chip in the M550 1TB drive and indeed Samsung's own controller in the 1TB 850 EVO? Unfortunately, we can't compare it directly against the MX100 as Crucial never produced a mega-capacity MX100, limiting it to 512GB max.

It has be said it holds up pretty well. In the ATTO benchmark it keeps pace with the 850 EVO and the M550 when it comes to sequential reads, but its Achilles' heel shows up in the ATTO sequential write test. Here it lags behind both the Samsung and the M550. It's the same story in the sequential write test of the AS SSD benchmark, with the BX100 lagging behind the other two.

However, when it comes to the AS SSD 4K (the small bitty files of everyday use) write test, the roles are reversed with the BX100 coming out the clear winner. Doing some real life testing, timing how long it takes to copy a 60GB Steam folder (29,521 files), the two Crucial drives are fairly close together, but both are left behind by Samsung's drive. Crucial may claim it's not the fastest drive around, but for the market it's aimed at, its overall performance isn't to be scoffed at. The same can be said for its performance in PCM08's Consistency test. Its overall best score of 4,913 is pretty good for a drive aimed at the lower end of the market.

The BX100 has decent endurance for a drive aimed at the budget end of the market too, being rated at 72TB of drive writes for the length of its three-year warranty. In the end with the BX100 then, Crucial has delivered yet another very good drive at a price point that will surely make the competition wince. –**SIMON CRISP**

VERDICT 8

Crucial BX100 1TB

⊞ **CENTURION** Decent performance; good price.

⊟ **SLAVE** Lacking features; middling results, especially some write speeds.

$375, www.crucial.com

BENCHMARKS

	Crucial BX100	Samsung 850 EVO	Crucial M550
AS SSD read (MB/s)	499	**510**	507
AS SSD write (MB/s)	419	**496**	480
4K read (MB/s)	25	25	**32**
4K write (MB/s)	**79**	67	71
60GB transfer (secs)	898	**857**	931
PCMark 8 Consistency	4,450	**4,691**	4,227

Best scores are bolded. The test rig is a stock-clocked Intel Core i7-3770K, in an Asus P8Z77 WS motherboard, with 8GB DDR3 at 1,866MHz.

SPECIFICATIONS

Capacity	1TB
NAND Type	Micron 16nm 128Gb MLC
Controller	Silicon Motion SM2246EN
Cache	512MB DDR3
Quoted Sequential Read Speed	Up to 535MB/s
Quoted Sequential Write Speed	Up to 450MB/s

Reboots galore, endless EULAs, countless user IDs? That'll be the Personal Cloud 2-Bay.

SPECIFICATIONS

Interface	Ethernet
Capacity	4TB
Dimensions (W x D x H)	9.25 x 9.21 x 1.89 inches
Weight	4.8lb
Warranty	Two years

Seagate Personal Cloud 2-Bay

We got personal. We did not double our fun

IF YOU'VE BEEN READING the papers, you've noticed our privacy isn't as private as we thought, especially when we use the Internet. In response, some storage companies now offer "personal clouds" to replace cloud services like Google Drive and Dropbox. This is basically a hard drive or SSD that's connected to your local network at home, and you can access it remotely and transfer files back and forth. It's not as reliable as a global network of data servers with redundancies and fallbacks in case of hardware failure, but there's no monthly fee, and you know exactly where your data is and who's looking at it.

The Seagate Personal Cloud 2-Bay is an enclosure with two hard drives in it. We tested the "4TB" version, which defaults to RAID 1. It's about two inches tall and nine inches square, so it needs a moderate amount of real estate. You'll find a gigabit Ethernet connector and one USB 2.0 connector in the back, and one USB 3.0 connector on the side, the latter of which is kind of an odd placement. The power button is also on the rear, which is awkward.

It came with no documentation. Instead, in tiny print on the device, was the URL: www.seagate.com/personalcloud-setup. On this web page, you'll find the actual stuff needed to make the thing work. Several Youtube videos and PDFs await, though we had to dig around to find the actual steps for the setup process. It's in the Quick Start Guide rather than the manual, and the guide is just a handful of pictographs without captions. We eventually discerned that you must also wait up to 10 minutes before the device shows up on the Wi-Fi portion of your network. No reason was given. This page also has a link to the "Sdrive" storage management software.

KNOCKING ON THE SKY

When we clicked on the drive in Windows Explorer, we were greeted with another EULA agreement. Then we were informed the device was going to download and install a firmware update, which requires the device to reboot. Twice. The firmware process took about five more minutes, after which we had to re-agree to Seagate's terms and conditions. After choosing between RAID 1 and RAID 0, given minimal information to work with, we created a Seagate Access ID to access the device remotely. This turned out to be unrelated to the Sdrive software, which for some reason requires its own ID and password.

The Sdrive desktop software reportedly hooks into the "Sdrive" app for Android and iOS. Not to be confused with the "Seagate Backup" app, which uses a "Seagate Account" instead of a Seagate Access ID or Sdrive login. And on the desktop, there's also a "Seagate Dashboard" client. Which you can't use without registering the device. Which we couldn't do because there was an error communicating with the server. We were then given the option to ignore registration and install the software anyway. Which required another EULA agreement. The device also has a web interface that operates independently of all this. You can't do backups there, but you can investigate the device's network settings, which are exhaustive.

Sdrive stubbornly resisted all attempts to connect our devices to the drive. The Seagate Backup app could coordinate with the Seagate Dashboard in theory, but it failed to detect the drive when on the local network. Eventually, we stumbled upon yet another piece of software, the Seagate Media App. Using our Seagate Access ID credentials, we were able to instantly see the drive both over Wi-Fi and over a cell network, the latter of which even supported streaming videos. After some fiddling with ES File Explorer, we could exchange files over the local network, and the Media App even recognized our Roku 3 and could cast photos and videos to it. When operating remotely, however, we could only transfer videos and photos using a cell network.

The 2-Bay actually works well enough as a locally networked storage backup device. That part of the Dashboard software is pretty sensible for creating, restoring, and maintaining local backups. And the built-in RAID redundancy is a nice feature. But the actual "cloud" part of things made us want to lie down and stare at the ceiling. **–TOM MCNAMARA**

VERDICT
5

Seagate Personal Cloud 2-Bay

⊞ **CLOUD NINE** Local backup software works well; RAID redundancy built in.

⊟ **STORM'S A-COMIN'** Poor setup experience; middling remote connectivity.

$300 (street), www.seagate.com

Gigabyte P35K V3

Is this the gaming laptop with it all?

THE FEEDING AND CARE of laptops is a fine art. Give your pet too much and its innards can burst out of its shell wherever there's a gap, like an obese tortoise. Alternatively, you can reduce the size of those innards to fit a smaller shell, and with that in mind, Gigabyte has chosen Nvidia's newest middle-end GPU, the Maxwell-class GTX 965M, to match this surprisingly svelte casing. Just because it's middling, however, doesn't mean it's a clunker, and we got some fantastic scores out of it in our benchmark tests.

TRACKPAD TERROR

The hardware is nothing unusual, with a Haswell Core i7 and 8GB of RAM backed up by a 128GB SSD and a 1TB spinner for storage. You get four USB ports, an SD card slot, Ethernet, one of those DVD drive things our folks used to use (you can swap this for another SSD or leave it empty to save weight, it pops out easily), and fancy 802.11ac Wi-Fi. There are virtual surround speakers, while external monitor enthusiasts are particularly well-catered for with VGA, HDMI, and 4K-friendly Mini DisplayPort lined up on the right-hand side of a case that's 0.8-inch thick with the screen closed.

The full-size keyboard isn't useless for a change. Although the keys don't have much travel, they are at least decently sized, but the accompanying trackpad feels like something the New York Rangers might like to play on. It's about as flexible as a frozen corpse, right-clicking when we wanted left, and failing to register double taps on many occasions unless we used the virtual buttons marked out on its lower quadrant. Even these proved unsatisfactory, the right-hand one in particular feeling as if it might snap if pressed hard enough.

This is a gaming laptop, however, and Real Gamers of course use Real Mice, so perhaps for its intended audience this won't be too much of a problem. The inclusion of an IPS panel is another rather nice touch, and it's certainly sharp, colorful, and bright, with a wide viewing angle for those who like to see what the person next to them on a train is playing. Plain black all over with a white backlight under the keyboard, the rest of the P35K's casing falls just the wrong side of that fine line between classy and dull.

A smaller case means less room for cooling, and while the P35K copes well, piping the heat out to a pair of fans in the corners of the unit, concerns were raised about its cooling efficiency when, after about an hour's play, and our fifth death at the hands of the first Captain, *Middle-earth: Shadow of Mordor*'s ultra-settings frame rate took a massive tumble. This could be taken as evidence of GPU throttling, or perhaps of the game's disdain for our skills. Either way, the GPU certainly supports dynamic clock speed changes, and can be switched off in favor of the integrated Intel HD chip to save power in less demanding situations.

TAKE AWAY

The supplied software isn't too intrusive, though some rather amusing translation work is on show (yes, "Make it Now!" is exactly what we'd like you to do, annoying backup program). We appreciate the shutdown button placed on the Windows 8 Taskbar, however.

If you're looking for a gaming laptop, the P35K should receive some serious consideration. Its combination of screen, core tech, and connectivity tick almost every box, and its slender dimensions actually make it genuinely portable. It's a rich mixture of power and usability, only let down by a terrible trackpad. **–IAN EVENDEN**

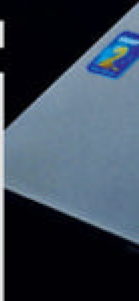
VERDICT
8

Gigabyte P35K V3

⊞ GIGGLEBYTE Slim chassis; powerful innards; good screen.

⊟ NIGGLEBYTE Terrible trackpad; looks a bit boring; questionable cooling capacity.

$1,449 www.gigabyte.com



BENCHMARKS

	Gigabyte P35K V3	P35K V1	XMG P505
Cinebench R15	658	625	**676**
X264 v4.0 (fps)	38.93	35.60	**41.14**
Heaven 4.0, 1080p (min/avg fps)	7/27	6/16	**17/54**
Bioshock Infinite, 1080p (min/avg fps)	13/52	7/30	**8/80**
GRID 2, 1080p (min/avg fps)	45/56	28/37	**62/73**
Price	$1,449	$1,199	$1,625

Best scores are bolded. All the 3D tests were carried out at their max settings with 4x antialiasing.

SPECIFICATIONS

CPU	Intel Core i7-4720HQ at 2.6GHz, turbo to 3.6GHz
RAM	8GB of DDR3L, 1,600MHz
Chipset	Mobile Intel HM87 Express
GPU	Nvidia GeForce GTX 965M (4GB of GDDR5)
Storage	128GB SSD, 1TB 7,200rpm HDD. Additional swappable drive bay

It may be less than an inch thick, but this portable still feels huge on your lap.

Kingston HyperX Cloud II

King of cans, back with 7.1 surround sound

DID WE EVER MENTION how much we love Kingston's luxuriant HyperX Cloud headset? Right. Once or twice. It's a rare combination of audio and ergonomic engineering working in perfect harmony, the closed-cup memory foam pads naturally amplifying the low-end frequencies emitted by the 53mm driver. Sure, the Kingston model is little more than a revision of QPAD's QH-90 headset with more bass and more branding, but the results are so good we can let all that go.

But this is where it all gets a bit complicated. The HyperX Cloud II is a revision on that revision, updating the visuals (read: adding some red bits), refining the inline remote, and importantly adding virtual 7.1 surround sound. Crucially, all the things we liked about the original model are still present and correct (red bits notwithstanding). They just come with extra bells and whistles now.

GOING VIRTUAL

We won't linger too long on the visuals, as any peripheral's appeal on those terms is subjective. Let's just trumpet two things. One: it's free of any tribal patterns, baffling ancient Greek mythos, or autographs from pro gamers you've never heard of—thank you, Kingston. Two: its construction quality is immediately apparent, and well-built never goes out of fashion. As with the original model, you get a choice of leather or velvet swappable earpads, and an adapter for use on planes. Nice touch. The mic isn't retractable, and its bulky pop shield might annoy you if you like your peripheral vision absolutely clear, but the tradeoff is remarkable mic fidelity. Some are even purporting greater clarity than in the original model, but we don't hear much of a difference.

The heart of the matter lies in the HyperX Cloud II's surround capabilities, though. Rather than jam each earcup full of individual drivers like some manufacturers, Kingston opts for an inline soundcard offering virtual 7.1 surround. And honestly, it's via virtual surround that we've heard the most immersive and convincing results in the past 12 months. The surround effect on this model can even be toggled on or off at the push of a button on that inline remote, which is handy if you're trying to perceive the exact effect it's having. How's it sound? Well, you'll want to stick to a stereo output for music, since there's a perceptible dip in fidelity with surround enabled, that slightly wooly "digitized" sound which comes with all virtual surround headsets. But if you want to lose yourself in a movie's surround mix or feel the war shaking your bones in a shooter, it does the job.

And that's largely down to the original construction and driver quality. Call it splitting hairs, but this isn't the most impressive virtual surround *tech* we've heard—Turtle Beach and Creative are ahead of the curve when it comes to playing tricks on your ears, and this model doesn't quite compete on that level. However, combined with the existing low-end power and clarity further up the EQ, it makes for, once again, just about the best overall package out there. The on/off button is the icing on the cake, giving you the meaty stereo mix you loved about the first model with one press, and something *slightly* lossier but more cinematic and crazy with another press.

Surround sound is the only meaningful difference between Kingston's two HyperX Cloud models, so it's important to make it clear that owners of the original model needn't lose any sleep about not having this headset. However, if you've already been holding out this long, your eventual purchase just became inevitable with the new model's arrival. Sorry. **–PHIL IWANIUK**

VERDICT 9 KICK ASS!

Kingston HyperX Cloud II

+ **HYPERDRIVE** Original benefits intact; solid surround.

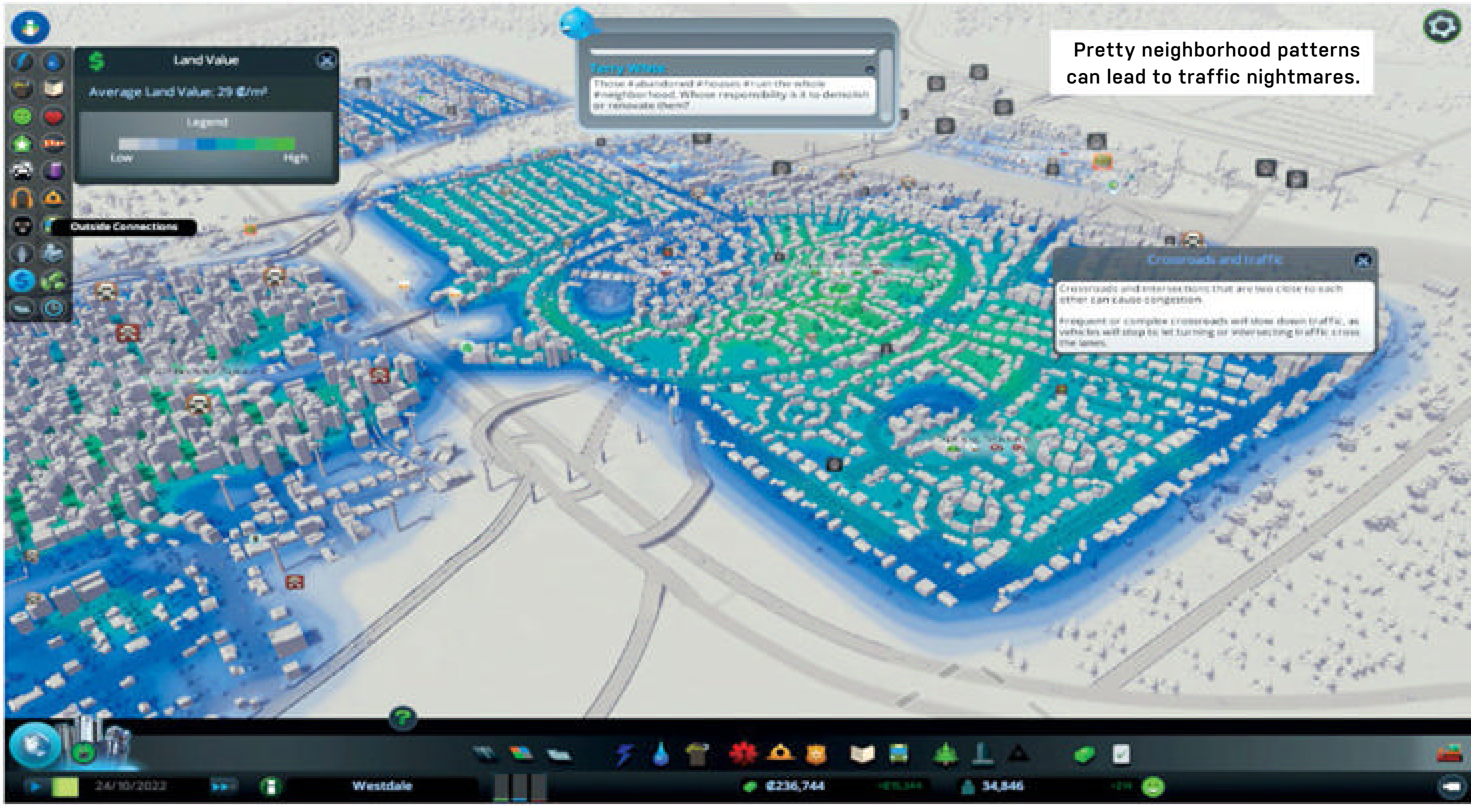
− **DRIVING MISS DAISY** Bulky mic (if we're being really harsh).

$100, www.kingston.com

SPECIFICATIONS

Frequency Response	15Hz–25KHz
Driver Size	53mm
Cable Length	1m + 2m extension
Connection Type	Single mini stereo jack plug (3.5 mm)
Mic	Condenser (back electret)

You're in for a tough game of spot the difference between this model and its predecessor.



Pretty neighborhood patterns can lead to traffic nightmares.

Cities: Skylines

Build it and they will come

IT'S WORTH REMEMBERING that the first game by Colossal Order was *Cities in Motion*, a pretty but buggy public transport simulation in static cities. It scored poorly. Given how Colossal Order has iterated on that shaky start to achieve the success that is *Cities: Skylines*, it makes us wonder what Maxis could have done if it'd been given one more chance at *SimCity* (the studio was shut in early 2015).

That transport simulation heritage is key here. Cities are, after all, where almost all human life happens, where the richest interactions and complexity occurs. A game developer could make a city simulation about just about anything—road maintenance, epidemiology, or fashion tribalism. But Colossal Order's grounding in *Cities in Motion*, and its obvious desire to outdo the failed *SimCity* by making this generation's definitive city-builder, has meant that it's made a quite traditional city-building sim, with a deep transport and population-movement simulation that underlies your actions.

The first time you play, the game just draws you into a headlong rush to build. You'll lay out some roads, zone the land around them into residential, commercial, and industrial areas, build some power plants, then run out of money. There's always another problem to solve, and you'll probably restart after five minutes, then again 10 minutes later. However, after that shaky start, the game's forgiving difficulty level will surely draw your town straight up to a megalopolis before you can say Mega-City One. That might take you six hours of solid play.

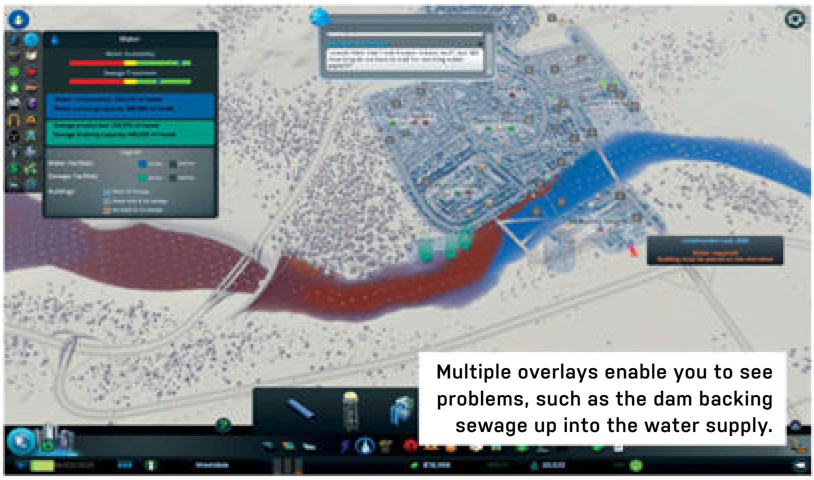
GENTLE PROGRESS

As your city develops, each population milestone unlocks more capabilities for you, along with new buildings for your city. The population's desire for goods only unlock when they become available too, making the game straightforward. As you pass a milestone, new problems emerge that you've just unlocked the solution to—the dead start piling up in your cemeteries, for example, just in time for a crematorium.

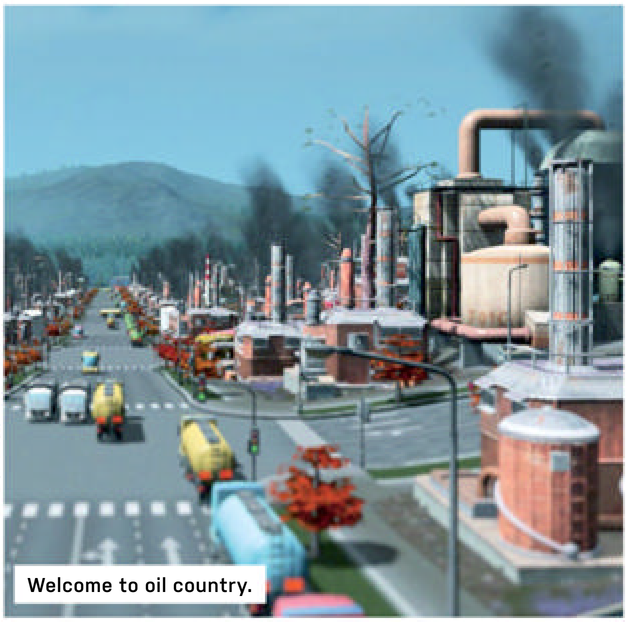
By the time you've solved them all, and built every building you need, and bought the new territory, it's time for another milestone, set of tools, and sometimes an increase in the playing area (which is huge compared to *SimCity*'s). After that starting section, the game is totally forgiving; you can just leave it running and stroll back half an hour later to find a healthy bank-balance happily ticking along.

But *Skylines* is a true sandbox—your targets are set by you. You choose what sort of city you want to build, how green it is, and what industries will dominate it. Our first time round we started with a totally green city, running entirely on wind power, but soon had to build a back-up coal power plant as our city outgrew the local windy areas and the weather proved unreliable. The outskirts of the city were a mess of grid roads, arbitrary one-way systems, and convoluted highways, while the center was a carefully laid out mesh of traffic circles which proved terrible for congestion, but looked beautiful from above.

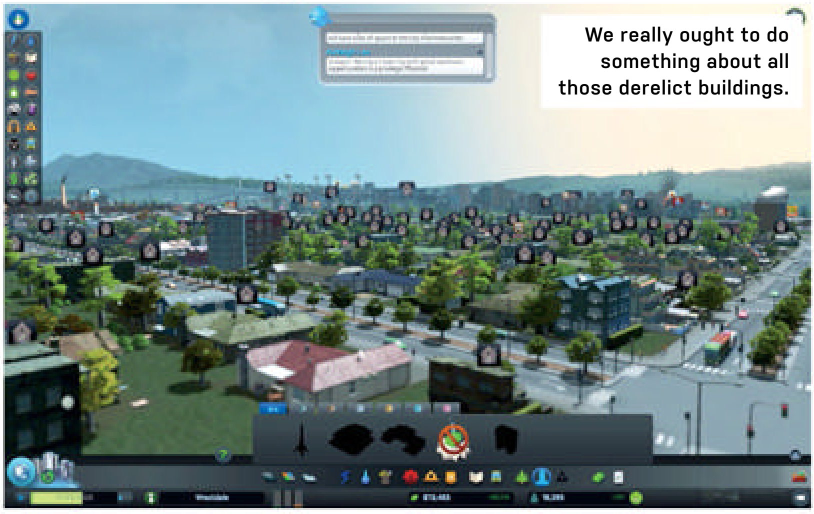
For the next build, we chose a different map and set ourselves a totally different goal, learning as we went. For the next we'll aim to avoid traffic jams, though we don't quite know how we should do that. However we play, bottlenecks seem to develop where vehicles sit in long queues, with all the essential services—police, ambulance, fire—sitting in slow-moving traffic. Our city centers are always an angry color in the traffic information overlay—just



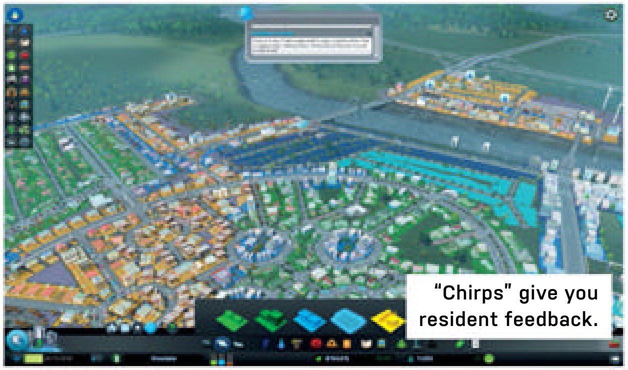
Multiple overlays enable you to see problems, such as the dam backing sewage up into the water supply.



Welcome to oil country.



We really ought to do something about all those derelict buildings.



“Chirps” give you resident feedback.

one of more than 10 overlays that help you decide what's most urgent.

The game does give you the tools to deal with more structural problems too. The information overlays allow you to find and isolate problems. For traffic, you can widen roads or plant trees along them at the expense of the buildings in a district. You can build parks to absorb pollution and distract the population.

Innovatively, the district tool lets you paint districts onto the world, then treat them differently—banning heavy traffic in the area or pushing up the tax among the rich, say, or banning pets, or legalizing drugs, or ordering the local industry to focus on oil extraction. You can also rename them, as you can buildings or even people. You can also follow the people as they move from home to work, wandering through the delicate-looking streets.

BEAUTIFUL BUILDINGS

One reason to play *Cities: Skylines*, rather than say *SimCity* or *Cities XXL*, is its raw beauty. The developers have fallen in love with the tilt-shift effect, and it makes every city look stunning. Tilt-shift is a photographic technique that makes normal photos look like miniatures, and is done by setting a narrow depth of field (so everything but the point of focus is blurred) and ramping the image's saturation up. That results in every screenshot of the game looking like a small sculpture.

There are bugs. Like building monorails in *Cities in Motion*, you can lose your youth attempting to build functioning highways and train lines. The route system is badly explained and hard to alter without accidentally deleting everything around it.

No matter how well you perform, entire neighborhoods can be abandoned overnight, requiring you to bulldoze every last building, one by one. Sometimes all the traffic sits stubbornly in a single lane, even on six-lane freeways. And we're fairly sure the water in rivers defies gravity at times. At least the game is extremely smooth running and doesn't need a crazy high-spec machine to strut its stuff.

There are flaws though. The game is, after all, essentially about taking up your time. There is absolutely no need for you to do everything that you have to. Building sewer networks, for example, is a massive chore, even if it's made as easy as possible. Likewise, deleting those abandoned or burned down buildings can feel like it's taking forever. And despite that, all you're really achieving is ticking boxes and generating better paths for your service traffic, so that you can unlock more buildings and keep going.

But that's the city-builder genre all over. If you think it's an unnecessary challenge, the sandbox mode gives you infinite money and unlocks all the buildings. If you want to really be tested, the hard mode is for you. However you choose to play it, *Cities: Skylines* is beautiful, smart, and astoundingly polished, if not as innovative as it first seems. –**DANIEL GRILIOPOULOS**

VERDICT 9

Cities: Skylines

SKY HIGH Beautiful tilt-shift styling; challenging systems; smart zoning tools; very much a game for fans of the genre.

TIE-DYE A few bugs; route system can be quite frustrating.

RECOMMENDED SPECS Intel Core i5-3470 3.2GHz/AMD FX-6300 3.5GHz; 6GM RAM; GeForce GTX 660/Radeon HD 7870.

$30, www.citiesskylines.com, ESRB: E

There's no next-gen wow-factor, so *Rogue* goes back to stabby basics.

Assassin's Creed: Rogue

Time to bid farewell to last-gen tech

"WHO AM I? WHAT YEAR IS IT? Who's the president?" These are not the cries of *Assassin's Creed: Rogue*'s befuddled modern-day protagonist, but those of the very journalist writing this review. *Rogue*, you see, is the seventh instalment of the franchise, a sequel to 2013's *Black Flag*, a prequel to 2012's *Assassin's Creed III*, and an introduction to *Assassin's Creed: Unity*. In fact, the series has become so ridiculously convoluted that another game, *Assassin's Creed: President Dog*, disappeared into a black hole created by all the time-warping confusion.

This head-scratching setup is partly due to the way Ubisoft chose to release the most recent games in the franchise. *Rogue* hit the Xbox 360 and PlayStation 3 last year, but very few people noticed because they were more interested in characters' faces turning inside out in *Assassin's Creed: Unity*, which debuted on the Xbox One and PlayStation 4. But, as we like to get the best of both worlds, Ubisoft has now decided to release *Rogue* on the PC.

This time round you take on the role of Shay Patrick Cormac, who, as you may have guessed, is an Irishman. His terrible "Oirish" accent, however, makes him sound more like a drunken extra from *Cheers*. Cormac's adventures take place in mid-eighteenth century New England, a period when lots of famous faces (Benjamin Franklin, George Washington) all happened to be in exactly the same place at once, handily allowing him to stumble across them. It's like *Forrest Gump*, but less idiot manchild and more stabs.

ALTERNATE REALITY

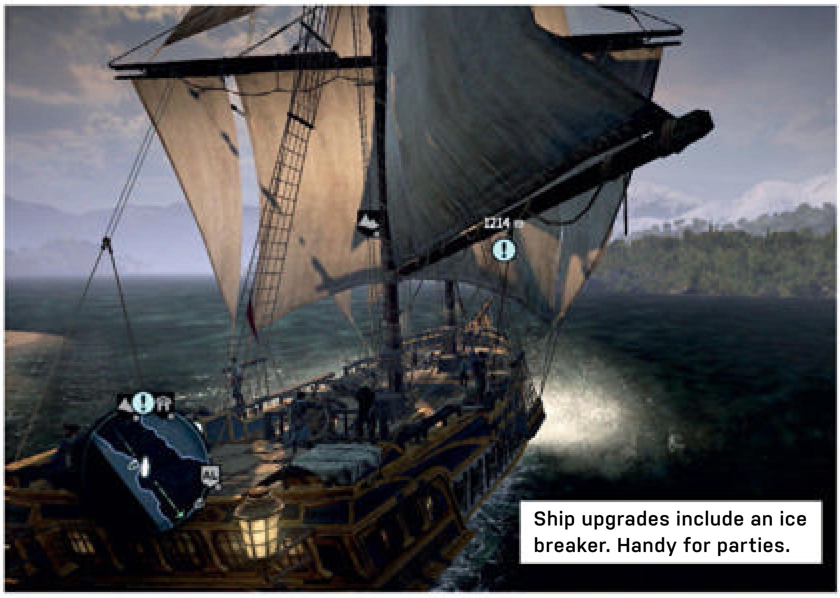
Meanwhile, back in near-future reality, Anonymous First-Person Guy is running around the high-tech offices of Abstergo Entertainment. Like the office chump he is, he completely screws something up, which requires further probing of Cormac's genetic memories to fix.

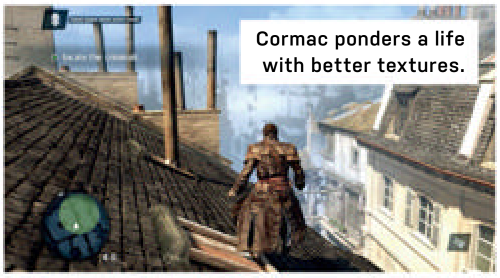
Despite the inherent silliness of the *Assassin's Creed* formula, there's still life in this dual-layered approach to reality, and it's one of the few game worlds which actually makes sense in the way that its protagonist can die a thousand times and see vital clues throughout levels. If Ubisoft plays its cards right, the *Assassin's Creed* franchise could become a really neat fit for virtual reality headsets some time in the not-so-distant future too.

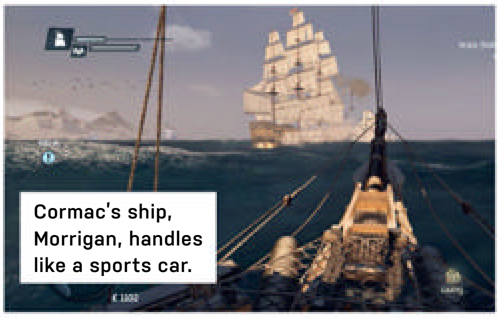
The real-world stuff is basically just admin at an intriguing office, but the game really kicks in when you're filling Cormac's boots. He starts out as an assassin, but after a disaster involving a few thousand deaths (d'oh!) he turns his back on them and becomes a Templar. It's a hefty twist—this time around, you're a bad guy—but the game happily bathes in the moral ambiguity between the two factions. This doesn't make a huge difference to the way it plays out, either—missions still rely on killing important people without being noticed, but at least Cormac gets an improbably accurate air rifle and a strangely anachronistic rocket launcher.

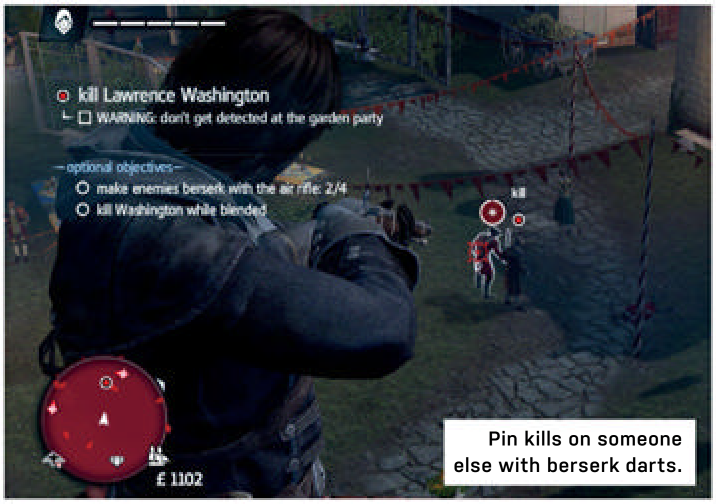
Rogue also steals one of the best bits of the previous few games: the naval warfare and exploration of *Black Flag*. Despite the sense of déjà vu, traversing the open water is still one of the best things the series has done. Huge waves cause the Morrigan, Cormac's ship, to heave and sway, and there's a thrill in pulling alongside enemy ships and unleashing your cannons.

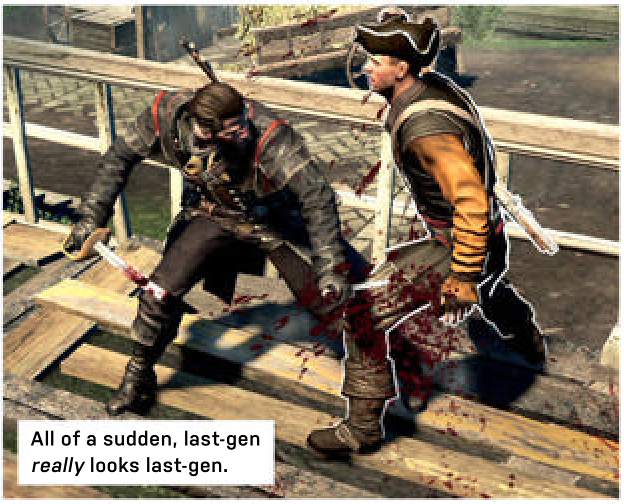
Unlike the balmy Caribbean in *Black Flag*, the action takes place in the frigid waters of the North Atlantic this time, so whenever Cormac enters the water he


Ship upgrades include an ice breaker. Handy for parties.


Cormac ponders a life with better textures.


Cormac's ship, Morrigan, handles like a sports car.


kill Lawrence Washington
WARNING: don't get detected at the garden party
optional objectives
make enemies berserk with the air rifle: 2/4
kill Washington while blended
£ 1102
Pin kills on someone else with berserk darts.


All of a sudden, last-gen *really* looks last-gen.

begins to catch a chill, preventing any long-distance swimming. It's a welcome touch of realism in a game where a 48m sloop-of-war handles like a Ferrari.

It's back on terra firma that cracks start to show. The graphics have been souped-up for the PC, with higher-res textures and some decent volumetric smoke effects, but these can't hide how dated the game looks. Some characters fall afoul of the notorious and deadly big hand syndrome, and their facial animations are puppet-like at best. Their hair is awful. Whole chunks of scenery are liberally copied and pasted across the landscape. And, as an open-world game, you can almost hear the "pop" as models and textures spring into place.

VISUALLY IMPAIRED

The funny thing is that the new generation of consoles didn't seem like a tectonic graphical shift when we first saw them, but 18 months down the line there's a noticeable difference between a last-gen game and its more modern counterparts. This, in part, seems to be down to the extra artistry that goes into modern games, where the pitch, yaw, and roll of every piece of rubble has been set by some betrodden art director at 3am, rather than created once and cloned liberally. In *Rogue* you soon tire of seeing the same Y-shaped tree trunk, the repetitive beach textures, and the same icebergs.

The question of whether this makes the game any worse remains, though. The thrill of being able to keep up with your prey as you leap over rooftops and haul yourself over walls hasn't diminished one bit, and managing New York's districts and gangs is as well thought through as *Grand Theft Auto*. While it largely plays it safe and doesn't rock the good ship *Assassin's Creed* too much, this also means that it doesn't have the bugs and issues that plagued the more eager-to-please *Unity*—and low system specs mean you don't need to rebuild your PC to run it.

We suspect that *Rogue*'s success has a lot to do with the way it was developed—the more excitable members of the Ubisoft team probably became weak at the knees and all frothy at the mouth at the thought of developing a next-gen game, while the more reliable developers took the opportunity to build on the already-pretty-damn-good last-gen games.

The result is a title which may lack the ambition of *Unity*, but one which is all the better for sticking to its well-established and rather deadly guns, and serves as a fitting send-off for last-generation tech.

–HENRY WINCHESTER

VERDICT

7

Assassin's Creed: Rogue

KILLER Awesome sailing; parkour is still great; engrossing open-world questing; story's a neat twist.

FILLER Showing its age; dull characters and voice acting; feels derivative at times.

RECOMMENDED SPECS 2.4GHz+ quad-core CPU; 2GB RAM; Radeon HD5670/GeForce GTS450/Intel HD4600.

$50, assassinscreed.ubi.com, ESRB: M

LAB NOTES

ALEX CAMPBELL **ASSOCIATE EDITOR**

A Gamer Grows Up

And Mom said computer games wouldn't get me anywhere

I'M EXCITED. Like, really, really excited. Think 15-year-old girl high-pitched squeal excited. Excited like your significant other's dog that you have to gently push away from your leg, as you silently scream for help from the parents you just met. The reason I'm so giddy is because I get to work as *Maximum PC*'s newest and slightly silly associate editor.

Computers have been a big part of my life ever since I was a wee lad. To say that I'm a computer geek would be a massive understatement. I've been playing with computers since I could sit high enough in a chair to see a screen.

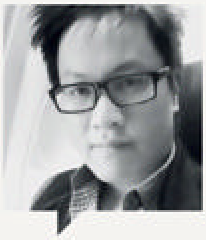
Nearly all the games I played were on PC, because my only console was a NES, and that mysteriously got flying lessons and "disappeared" one day. Coincidentally, the day after I pissed off my Dad. I still regret that, too: *Super Mario Brothers 3* was an awesome game. But being a PC gamer showed me that PCs were always ahead of consoles, both in terms of power and graphic performance.

I built my first PC so I could play *Quake III Arena* soon after the game's launch. (In case you're curious, that rig featured an AMD Athlon, a 3dfx VooDoo 3 2000 AGP, and was dubbed "UGM" after a build by *The Screen Savers* on ZDTV.) Not long after that, I started experimenting with Linux on the old K6-2 machine I had been using before.

I'm primarily a Linux user at home, and I'm a big advocate for free software. I run Arch Linux on all three of my computers and dual boot Windows 8.1 on two of them.

Dad, if you're still hiding my NES, I'd love to get it back at some point.

I could go on, but the most important thing is that this is going to be an awesome ride, and you're coming with me, dear reader. I'll drag you by your hair if I have to.



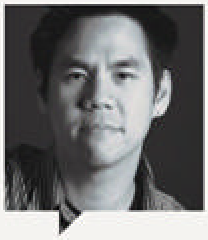
TUAN NGUYEN

Editor-in-Chief

Firewalls are common in consumer routers and offer basic NAT and features like DMZ. More advanced routers come with VPN client/server features, and Quality of Service options. But what if you wanted the ultimate firewall? Build one yourself.

Enter pfSense. Started as an open-source project, pfSense is lightweight, fast, and runs on most hardware. You could build a machine yourself and set up a homebrew super firewall with options out the wazoo.

pfSense also sells devices that perform these duties if you'd prefer they do it for you. They start at about $450, but deliver firewall sophistication that's good enough to secure an enterprise. Try it out!



JIMMY THANG

Online Managing Editor

After attending this year's Game Developers Conference (GDC) in San Francisco back in March, I'm more confident than ever that virtual reality is here to stay.

Don't get me wrong, virtual reality still has a ton of issues, like motion sickness and interactivity problems, to overcome. But after trying Valve's VR system, which allows you to walk around and use your arms, I think we're on the right track.

Plus, there are a lot of smart people (and money) being thrown at the situation. When you have the likes of Oculus VR, Nvidia, AMD, Epic, and Crytek investing heavily in VR, I suspect it's only going to be a matter of time until we all get to enter the Matrix.

First Look:
Valve-HTC Vive

The closest thing we have to the Holodeck

WE GOT A CHANCE TO TRY Valve's VR system at the Game Developers Conference (GDC), and it's the best VR experience we've had yet. This is the closest thing to a modern-day Holodeck there is at the moment.

Built in partnership with HTC, and named Vive, the head-mounted display (HMD) uses two 1080x1200-resolution displays, one for each eye. The FOV is around 100 degrees. While we could still make out the pixels, it's hardly distracting and is definitely sharp enough for consumer release.

Like the Oculus Rift HMD, the Vive will be wired, and like Oculus's Crescent Bay prototype, it supports a 90Hz refresh rate. Beyond that, there are some key differences. Instead of depending on a single external camera for head tracking, Valve has two "lighthouses," which users must place at opposite ends of their room. These simply need to be powered (rather than plugged into your PC) and they emit red lasers that assist the Vive in supplying 360-degree room scale tracking, which allows you to map out your walkable space. The lighthouses also help identify Valve's new VR controllers.

The controllers are very similar to the Razer Hydra controllers, except will be wireless (the prototype unit we tested used a wired solution, but we hear there are working wireless ones out there in the wild). The controllers have sensors that work with the lighthouses to detect where they are in your VR experience, meaning you can see your hands in the game. The controllers have a circular touchpad on the front, a trigger button on the back that essentially allows you to grab things (à la crab hands), and long buttons on the side of the stick that you can squeeze. The controls were nearly 1:1 and are definitely the best VR controllers out there, better than Sixense's similar Stem VR system. There are also a bunch of little cameras on the front of the headset that leverage the position of the lighthouses to provide positional tracking, which not only lets you lean into objects but to walk around as well. One big problem with VR pertains to response time; we tried shaking our head as fast as we could to see if we could experience any judder and are glad to report we experienced no such lag.

The half a dozen demos we tried were all fantastic. One took us to the bottom of the ocean atop a sunken pirate ship and allowed us to walk around the deck as a giant blue whale swam past. Another placed us in a kitchen and asked us to walk around and pick up ingredients to cook in a pot. We also tried a game called *The Gallery: Six Elements* that had us looking at a giant rock monster in a *Lord of the Rings*-style universe. Finally, we opened a bunch of funny drawers via a *Portal 2* demo that looked gorgeous with its new Source 2.0 engine.

Compared to other VR solutions, Valve is at the top of the heap. Its headset is sharp, offers a great sense of depth, has excellent tracking, allows you to walk around, didn't make us motion sick, and comes with an excellent controller that works well. Valve says a dev kit should be released by the fall, and the consumer release should be coming at the end of the year. If we do have one concern, however, it's price. All of this sounds expensive, but we might just sell our own legs for this if it means we can have virtual ones. **–JT**

The headset will be wired but still allow you to walk around.

GEEK TESTED & APPROVED

Seagate Wireless 500GB

THIS HARD DRIVE STINKS. No, seriously. The first time we opened the box, we were greeted with a bright green device and an unexpected olfactory experience. And it didn't smell like lush forest, key lime pie, or a meadow after a spring rain.

After plugging the 500GB drive's included USB cable into a PC to charge, we realized it doesn't come with an AC wall adapter. The lack of an included AC adapter seems like an oversight, especially since Seagate's FAQ says the device charges in three hours with an AC wall plug, or nine hours using a PC's USB 3.0. While plugged into a PC via USB 2.0, the drive functions like any other USB drive. When disconnected and turned on, it turns into a Wi-Fi NAS device. It can be used as NAS while plugged into an AC adapter, but can't pull double duty as NAS and USB storage at the same time.

By default, it creates its own unsecured Wi-Fi network that supports up to three devices. While it's pretty easy to secure it through the mobile app, we would've liked to see WPA enabled by default and the key printed on the device. It can automatically connect to a Wi-Fi network just like your phone, so it can be available on your office's network when you get to your desk. Just be careful not to turn on the auto-upload feature in the Android or iOS app, or your coworkers will be able to see all your photos.

Overall, this Seagate is a handy way to store files on the go, if you're OK with a couple of quirks, have an extra wall plug, and don't mind the odor. **–AC**

$100, www.seagate.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Gaming Laptops
> Overclocked Graphics Cards
> CPU vs. GPU Upgrades

Future-Proof Laptop

I'm considering a new MSI gaming laptop to replace my way-over-the-hill Gateway P7811-FX. Price and weight are not major concerns, but gaming longevity is important. Certain 17-inch MSI models offer the ability to upgrade the GPU, while certain 18-inch models offer dual GPUs in SLI. Which feature offers the greatest gaming longevity? Which will allow me to game with all the eye candy turned on for the longest period over time? Is there a better system I should consider? Please help. I'm tired of not being able to play even 3-year-old games without my laptop crashing. Thank you for your advice. **—Brian**

ONLINE MANAGING EDITOR JIMMY THANG RESPONDS: Hey Brian, while adding a secondary GPU never doubles performance precisely, it can get close. But for a gaming notebook, we think two cards in SLI will give you more of a future-proof setup (considering price doesn't seem to be a factor). It's true some gaming laptops are allowing you to swap out the graphics card, but the market isn't very big yet. As a result, trying to find a compatible mobile GPU will be more difficult on a laptop than on a desktop. Plus, the nice thing about an SLI setup is that you know the manufacturer has tested the unit to ensure the thermals and compatibility are solid. If you're looking for something with a bit of both, MSI does have its GT80 Titan, which offers two mobile MXM GPUs that the company says you'll be able to swap out later on.

[NOW ONLINE]

AMD'S LIQUIDVR SDK AIMS TO SOLVE VR ISSUES

Did you know that having two graphics cards in CrossFire hinders VR experiences? That's because they're optimized for performance throughput, and not latency, which is vital for keeping your lunch down. AMD hopes to solve that problem with its newly announced LiquidVR SDK, which will allow you to use each individual graphics card to render to each eye. That is but one way LiquidVR is attempting to solve VR's many issues. Check out our online interview with AMD Graphics CTO Raja Koduri as we discuss how the SDK will also help reduce judder, comfort, and compatibility issues. http://bit.ly/MPC_LVR

Asynchronous Shaders

AMD's CTO Raja Koduri talks VR SDK.

Overclock Value

I'm building a new rig and want to incorporate a new GTX 980 graphics card. My dilemma is sorting out the best and worst of the bunch. I understand vendors pick components to overclock their products, but prices range between $500 to $800 for what essentially is a few megahertz. For example, EVGA offers two cards: one at 1.24GHz for $619 and another at 1.3GHz for $806. Does the difference in performance warrant the $200 bump? My biggest concern, though, is who will have the latest, most stable, and feature-rich software drivers? I've been burned in the past by vendors that merge, go out of business, or stop updating their drivers. **—Steve H.**

TECHNICAL EDITOR TOM MCNAMARA RESPONDS: Hi, Steve. Those super-expensive cards are usually designed to be cooled with liquid nitrogen, or unicorn dust. But the GTX 980 GPU is so power efficient you don't need to blow a lot of cash for a special variant. We recommend avoiding the "reference" cooler, which looks like this one: http://bit.ly/MPC_GTX980. EVGA

↘ submit your questions to: comments@maximumpc.com cards that use the "ACX 2.0" coolers are great. Gigabyte makes a nice "Windforce" version. MSI has its "Gaming 4G" model. And Asus "Strix" and "Matrix" cards are pretty reliable.

> SUPER-EXPENSIVE CARDS ARE DESIGNED TO BE COOLED WITH UNICORN DUST.

NUC Storage

What a timely article on SSDs. I'm trying to figure out if I should go with a traditional SSD or an M.2 piece in a new NUC5i5. I can't tell if this NUC uses a M.2 interface with the NMVe protocol. If not, then I need the RYH model that can fit a 2.5-inch SSD. Do you guys know? **—Matthew**

ONLINE MANAGING EDITOR JIMMY THANG RESPONDS: Hi Matthew, there are different versions of the NUC5i5. The NUC5i5RYK we reviewed on page 76 only supports M.2, but the NUC5i5RYH supports both M.2 and traditional 2.5-inch SSDs. If you go for the RYH, we'd suggest a 2.5-inch drive for the time being, as they're much cheaper. That is, if you're OK with the SATA III 6Gb/s limit.

Upgrade Quandary

I'd like to upgrade my PC, but I'm torn. I've an MSI GTX 560 Ti graphics card and was considering upgrading to an MSI GTX 970. I've heard good things, despite the memory controversy. I've a 1440p monitor, so I think a 970 would give nice frame rates on fairly high settings. Apparently, it's good value, although I also had my eye on the GTX 980, to guarantee good performance. On the other hand, I've an AMD FX-8350 CPU (4GHz) and Asus Crosshair V Formula motherboard, and was considering upgrading to an Intel CPU and motherboard. Considering I mostly use my PC for things other than gaming, I thought this might be more justifiable. I was looking at the Intel Core i7-4790K and the Asus Maximus VII Hero motherboard, but I'd be glad to hear suggestions.

I like to do a lot of digital painting with Photoshop-like software (ArtRage), and a lot of general use and multitasking. Do you think the CPU upgrade would give a good performance boost in my digital painting software, as opposed to the GPU upgrade? **—Jordan**

EDITOR-IN-CHIEF TUAN NGUYEN RESPONDS: Hi, Jordan. The GTX 560 Ti is quite dated for sure, and your biggest benefit, gaming-wise, would be to upgrade to a GTX 970 or 980. But if your time is spent doing mostly content creation, I'd invest in a new platform altogether, with the Core i7-4790K. Digital paint software rarely uses GPU power. Just remember that the CPU is a far more costly upgrade because it requires you to replace other components.

To Defrag or Not

After reading the SSD roundup from your April issue, I've been wondering. You've stated before that you don't want to defrag an SSD because it won't help performance, but will shorten the life of the drive. I understand the shortening of the life, but unless I'm misunderstanding the performance metrics chart in that article, then I'd say the performance is increased by a factor of more than 10!

For example, on the SanDisk Extreme Pro 480GB you show the ATTO Peak Read/Writes as 554/520. Even the AS SSD Average was 506/474. That is the sequential read/write, right? Then the AS SSD 4K read/write, which I am interpreting as the random (non-sequential) read/write speeds were 30/103. So we're going from 506MB/sec read to 30 MB/sec. And that's not a performance drop? Perhaps I'm reading the chart wrong. **—Dan**

TECHNICAL EDITOR TOM MCNAMARA RESPONDS: Dan, what you're seeing is a problem common to all storage devices, which is that random reads and writes happen a lot more slowly than sequential ones. It's not related to drive fragmentation. SSDs handle that second problem automatically, with a "trim" command scheduled periodically by Windows 7, 8, or 10. Some SSDs come with software that lets you invoke the command manually, but it's generally not needed.

Facebook Polls

The Big Switch

This month we asked our Facebook buddies what it would take for them to switch to Linux. Here are some of our favorite responses.

Geoff Goldsmith: When every new game supports Linux. You can't even stream Netflix!

Patrick McCullough: I'm not unhappy with Windows 7/8.1. Blasphemy, I know.

Michael Small: There needs to be better driver support and it needs to be simpler to use. I find myself using the terminal a lot just to do something that should be simple. I don't have time to learn all these damn commands.

Dustin Lanter: Support for 90 percent of my games and apps that work fine on Windows.

Greig Jones: Already did. So many misconceptions about Linux. It's super easy to install and run out of the box. Did I mention it is free? Did I mention Steam for games? Did I mention lack of viruses? Did I mention updates are frequent and take a very short time to install. A lot to like about Linux.

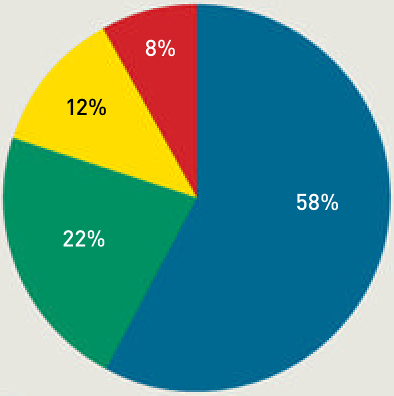
William J. Nelson: Proper AMD graphics drivers. Its a nightmare right now for anything past the 7xxx series.

Kevin Orr: If Windows ever charged a subscription fee, I'd change in a heartbeat.

Kevin Hall: Did last year, no regrets.

Jesse Beukenboom: Drivers! Linux desperately needs driver support from hardware manufacturers for printers, soundcards, GPUs, mobos. You get my drift.

Have you ever overclocked your videocard?



🟦 Yes, and it was successful.

🟩 Yes, but it didn't work out as I'd hoped.

🟨 No, but I would like to give it a try.

🟥 No. Just, no.

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INGREDIENTS

PART			PRICE
Case	NZXT Source 210 Elite		$50
PSU	Corsair CX600M 600W	**NEW**	$48
Mobo	Gigabyte H97-D3H		$95
CPU	Intel Core i5-4440	**NEW**	$174
GPU	Sapphire Radeon R9 280 Dual-X	**NEW**	$173
RAM	2x 4GB G.Skill Ares Series DDR3/1600	**NEW**	$55
SSD	120GB SanDisk Ultra Plus		$50
HDD	Seagate Barracuda 1TB		$60
OS	Windows 8.1 64-bit OEM		$100

Approximate Price: $805

INGREDIENTS

PART			PRICE
Case	Corsair Vengeance C70		$120
PSU	EVGA SuperNOVA 850 220-GS-0850-V1		$120
Mobo	Asus Z97-A Pro Gamer	**NEW**	$150
CPU	Intel Core i5-4690K		$230
Cooler	Silverstone TD02-E	**NEW**	$90
GPU	Sapphire Tri-X Radeon R9 290		$270
RAM	2x 4GB G.Skill Ares Series DDR3/1600	**NEW**	$55
Optical Drive	Samsung SH-224DB/BEB		$20
SSD	256GB Samsung 850 EVO	**NEW**	$100
HDD	Seagate Barracuda 3TB ST3000DM001		$103
OS	Windows 8.1 64-bit OEM		$100

Approximate Price: $1,358

THE CORSAIR CX600M will get you enough juice for pretty much any single-GPU videocard, and we've had good experiences with a variety of their PSUs. At less than $50 after a rebate, it's a no-brainer. We're also upgrading from an Intel Core i3 to an i5, which will pump up your gaming muscle. This Gigabyte H97-D3H mobo is compatible with Intel's upcoming Broadwell CPUs, so you have more options down the road. The Radeon R9 280 isn't as fast as the 285 we had in here last time, but we needed to shave costs to fit in the i5. This system will still be faster overall. SanDisk makes some high quality SSDs at very competitive prices, so we're sticking with the Ultra Plus (in addition to a hard drive for media and backups).

THE CORSAIR VENGEANCE C70'S toolless side panels are super handy when you tinker as much as we do. The Asus Z97 Pro Gamer has a high-octane 3D positioning audio chip and the company's "AI Suite" software package, which has high tweakability and an approachable interface. The 850 EVO is a snappy SSD and comes with some nice drive-management software. The Radeon R9 290 is arguably your best gaming value, and the Sapphire Tri-X version should stay cool and quiet. But if you want to add another, you'll need a throaty power supply like this EVGA SuperNOVA 850G, which delivers 70 amps on a single rail. If you've $100 more, consider the i7-4790K, since DirectX 12 looks like it will take meaningful advantage of Hyper-Threading.

TURBO

IT'S REALLY A 1,300-WATT POWER SUPPLY, but the combination of the SuperNOVA's price and quality is too good to pass up. We used the 1,600-watt version in last year's Dream Machine, which powered four demanding GPUs, highly overclocked CPU, bunches of case fans, and a water-cooling pump, without breaking a sweat.

But we did change our case from the Corsair 750D to the 780T, which we found roomier. The toolless doors are also handy. The Intel Core i7-5820K has six CPU cores, but "only" 28 PCI Express Lanes. So you could make an argument for upgrading to the i7-5930K, if you want three to four GPUs in this system. We switched the CPU cooler from the Corsair H110i GT because there's apparently been a hiccup with supply. The Cooler Master Nepton 280L is a great alternative. The Asus X99 Pro is not cheap, but it's been a smooth overclocker for us. We could upgrade the videocards to the Nvidia GTX Titan X, but at $1,000 a pop, they're difficult to justify unless price is no object.

For more of our component recommendations, visit www.maximumpc.com/best-of-the-best.

INGREDIENTS

PART			PRICE
Case	Corsair Graphite 780T	**NEW**	$160
PSU	EVGA SuperNOVA 1300 G2		$161
Mobo	Asus X99 Pro		$315
CPU	Intel Core i7-5820K		$380
Cooler	Cooler Master Nepton 280L	**NEW**	$100
GPU	2x EVGA GeForce GTX 980 Superclocked ACX 2.0		$1,100
RAM	4x 4GB Kingston HyperX Predator DDR4/2666	**NEW**	$162
Optical Drive	LG Blu-ray Burner WH16NS40		$70
SSD	Samsung 850 EVO 500GB		$187
HDD	Seagate Barracuda 3TB ST3000DM001		$103
OS	Windows 8.1 64-bit OEM		$100

Approximate Price: $2,838

UPGRADE OF THE MONTH

SILVERSTONE TD02-E

This revision of the TD02 has larger tubing, which helps with temperatures, and a less thick radiator, which lets it fit in more cases. The radiator's densely packed fins also give it nearly the performance of a larger one, for less. It's also a quiet performer.

$90, www.silverstonetek.com

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